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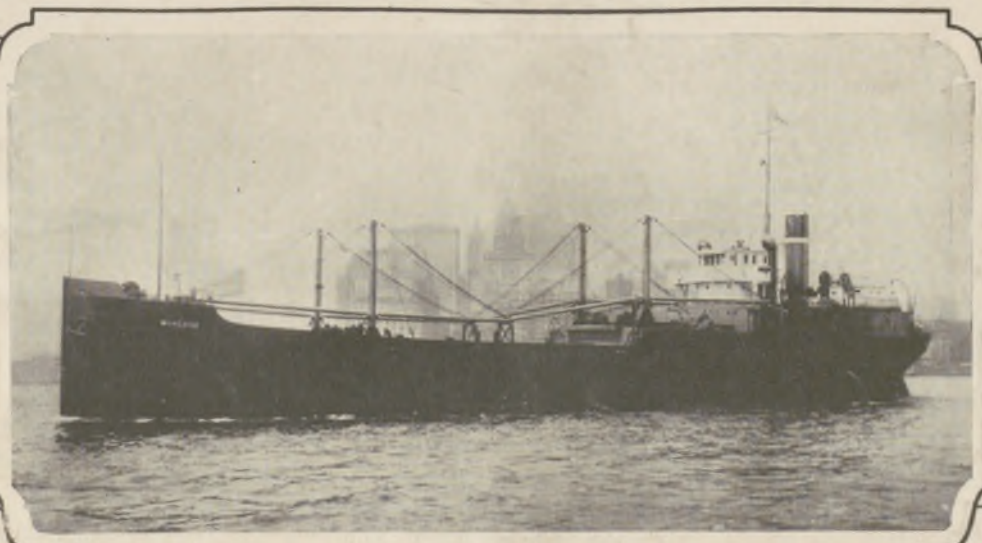
Motorship

New York Seattle San Francisco

FEBRUARY, 1924

MARINE DIESEL ENGINES
FOR ALL CLASSES OF SHIPS



M. S. MUNCOVE
Length 353'6", Width 43'6", Depth 27'6"
Draft 23'6", Deadweight Capacity 4125 Tons
Single Screw, 1200 I.H.P., Oil Engine

McINTOSH & SEYMOUR CORPORATION
MAIN OFFICE AND WORKS - AUBURN, N.Y.

Volume IX, No. 2 Price, 25 Cents

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EXCLUSIVE technical and non-technical articles on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

Motorship

PROFUSELY illustrated with photographic reproductions of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.

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Greene Amendment to the Jones Act

A Reproduction of the Bill Introduced by Congressman William S. Greene of the Committee on Merchant Marine and Fisheries to enable Diesel Engines to be Installed in Existing Steamships of the American Mercantile Marine

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 11 of the Merchant Marine Act, 1920, be, and the same is hereby, amended to read as follows:

"SEC. 11. (a) That during a period of five years from the enactment of this Act (Merchant Marine Act, 1920) the board may annually set aside out of the revenues from sales and operations a sum not exceeding $25,000,000, to be known as its construction loan fund. The board may use such fund to the extent it thinks proper, upon such terms as the board may prescribe, in making loans to aid persons citizens of the United States in the construction by them in shipyards of the United States of vessels of the best and most efficient type for the establishment or maintenance of service on lines deemed desirable or necessary by the board, provided such vessels shall be equipped with the most modern, the most efficient, and the most economical machinery and commercial appliances or, in the equipment by them in shipyards of the United States of vessels already built, with machinery and commercial appliances of the type and kind mentioned.

"(b) The term 'vessel' or 'vessels,' where used in this section, shall be construed to mean a vessel or vessels to aid in whose construction or equipment a loan is made from the construction loan fund of the board. All such vessels shall be documented under the laws of the United States and shall remain documented under such laws for not less than 5 years from the date the loan is made; and, so long as there remains due the United States any principal or interest on account of such loan.

"(c) No loan shall be made for a longer time than fifteen years. If it is not to be repaid within two years from the date when the first advance on the loan is made by the board, the principal shall be payable in installments to be definitely prescribed in the instruments. Such installments shall be made payable at intervals not exceeding two years; and in amounts not less than 6 per centum of the original amount of the loan, if the installments are payable at intervals of one year or less; and in amounts not less than 12 per centum of the original amount of the loan, if the installments are at intervals exceeding one year in length. The loan may be paid at any time, on thirty days' written notice to the board, with interest computed to date of payment.

"(d) All such loans shall bear interest at rates to be fixed by the board, payable not less frequently than annually. During any interest period in which the vessel is operated exclusively in coastwise trade, or is inactive, the rate of interest shall be not less than 5¼ per centum per annum. During any interest period in which the vessel is operated in foreign trade, the rate shall be not less than 4¼ per centum per annum. The board may prescribe rules for determining the amount of interest payable under the provisions of this paragraph.

"(e) No loan shall be for a greater sum than one-half the cost of the vessel or vessels to be constructed; or, than one-half the cost of the equipment hereinbefore authorized for a vessel already built: *Provided, however,* If security is furnished in addition to the mortgage on the vessel or vessels, the board may increase the amount loaned, but such additional amount shall not exceed one-half the market value of the additional security furnished, and in no case shall the total loan be for a greater sum than two-thirds of the cost of the vessel or vessels to be constructed; or, than two-thirds of the cost of the equipment, and its installation, for vessels already built.

"(f) The board shall require such security as it shall deem necessary to insure the completion of the construction or equipment of the vessel within a reasonable time and the repayment of the loan with interest; when the vessel is completed the security shall include a preferred mortgage on the vessel, complying with the provisions of section 30 of the Merchant Marine Act, 1920, which mortgage shall contain appropriate covenants and provisions to assure the proper physical maintenance of the vessel; and, its protection against liens for taxes, penalties, claims or liabilities of any kind whatever, which might impair the security for the debt. It shall also contain any other covenants and provisions the board may prescribe, including a provision for the summary maturing of the entire debt, for causes to be enumerated in the mortgage.

"(g) The board shall also require and the security furnished shall provide that the owner of the vessel shall keep the same insured against loss or damage by fire, and against marine risks and disasters, and against any and all other insurable risks the board specifies, with such insurance companies, associations or underwriters, and under such forms of policies, and to such an amount, as the board may prescribe or approve; such insurance shall be made payable to the board and/or to the parties, as interest may appear. The board is authorized to enter into any agreement that it deems wise in respect to the payment and for the guarantee of premiums of insurance."

SEC. 2. That section 12 of the Merchant Marine Act, 1920, be, and the same is hereby, amended by adding at the end thereof a new paragraph to read as follows:

"The term 'reconditioned' as used in this section includes the substitution of the most modern, the most efficient and most economical types of internal-combustion engines as the main propulsive power of vessels. Should the board have any such engines built in the United States and installed, in shipyards of the United States, in one or more merchant vessels owned by the United States, and the cost to the board of such installation exceeds the amount of funds otherwise available to it for that use, the board may transfer to its fund from which expenditures under this section may be paid, from its construction loan fund authorized by section 11 of the Merchant Marine Act, 1920, so much as in its judgment may be necessary to meet obligations under contracts for such installation; and the Treasurer of the United States shall, at the request of the board, make the transfer accordingly: *Provided,* That the total amount hereafter expended by the board for this purpose shall not in the aggregate exceed $25,000,000. Any such vessel hereafter so equipped by the board under the provisions of this section shall not be sold for a period of five years from the date the installation thereof is completed, unless it is sold for a price not less than the cost of the installation thereof and of any other work of reconditioning done at the same time plus an amount not less than $10 for each dead-weight ton of the vessel as computed before such reconditioning thereof is commenced. The date of the completion of such installation and the amount of the dead-weight tonnage of the vessel shall be fixed by the board: *Provided further,* That in fixing the minimum price at which the vessel may thus be sold the board may deduct from the aggregate amount above prescribed 5 per centum thereof per annum from the date of the installation to the date of sale as depreciation: *And provided further,* That no part of such fund shall be expended upon the reconditioning of any vessel unless the board shall have first made a binding contract for a satisfactory sale of such vessel in accordance with the provisions of this Act, or for the charter or lease of such vessels for a period of not less than five years by a capable, solvent operator; or unless the board is prepared and intends to directly put such vessel in operation immediately upon completion. Such vessel, in any of the enumerated instances, shall be documented under the laws of the United States and shall remain documented under such laws for a period of not less than five years from the date of the completion of the installation, and during such period it shall be operated only on voyages which are not exclusively coastwise."

A PRACTICAL MERCHANT-MARINE, AND WORK FOR OUR SHIPYARDS, EQUIPMENT FACTORIES, AND ENGINE PLANTS

IT is expected that the Bill on this page will be passed by Congress in about one month. Not only will it be a splendid thing for our merchant marine, but it will provide badly needed work for American shipyards, oil-engine plants and for manufacturers of all kinds of marine equipment.

***Motorship* recently pointed out that the Board has authority to go ahead with a number of conversions without waiting for Congressional action. This the Board will do as it finds it has enough money on hand to start work on about ten ships.**

Based on the solid foundation of economy, at last the oil-engined motorship is coming into its own in the U. S. A.!

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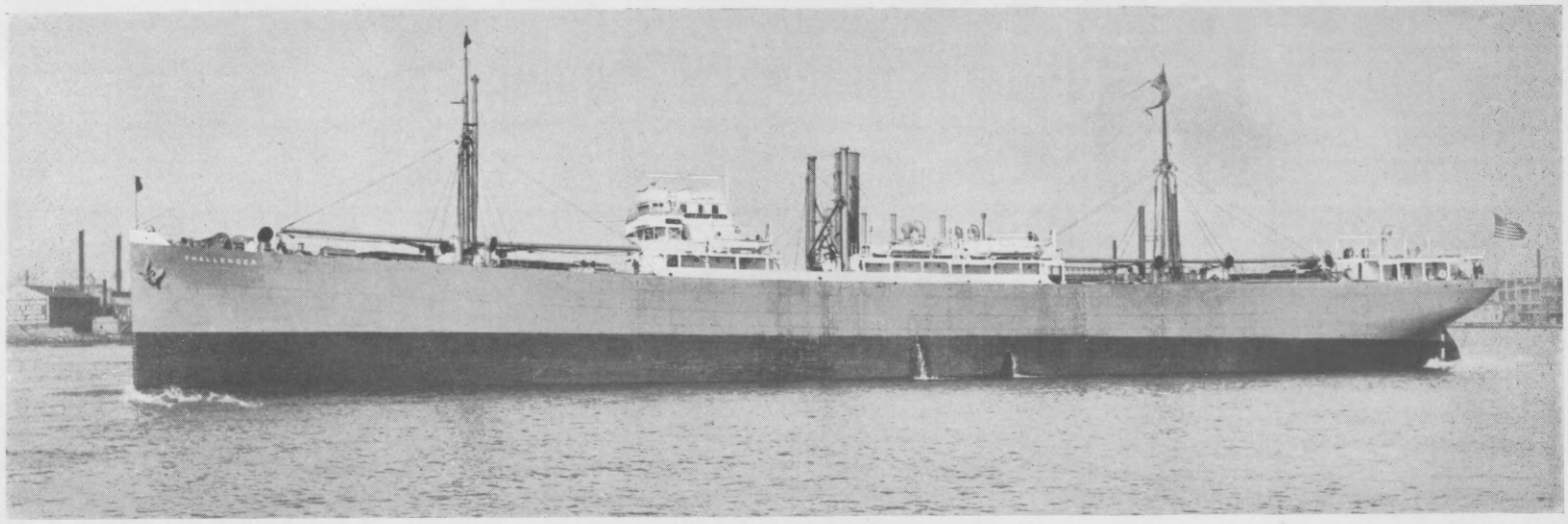


Single-screw cargo motorship "Challenger" on trials. She was converted from a Shipping Board 11,850 ton dw. steamer to Sun-Doxford Diesel power by the Sun Shipbuilding Co., of Chester, Pa.

First American Freighter With Opposed-Piston Oil Engines

Converted Steamer Challenger Runs Trials with Her New Sun-Doxford Diesel Engine

FORMING the largest steamer yet converted to motor power in the United States, if we except the WILLIAM PENN originally laid-down as a steamer *but* equipped with Diesel power without the steam machinery ever being installed, the CHALLENGER has just run trials on the Delaware. This ship is an object of interest to all men interested in maritime affairs. She was purchased by the Sun Shipbuilding Co. and equipped with a big single-screw Sun-Doxford Diesel engine entirely at their own expense, and is the third of three vessels thus treated by this company, the first two being the tankers MILLER COUNTY and BIDWELL.

We were present recently at a demonstration run on the Delaware made at a psychological time—just as the House Committee on Merchant Marine were considering the advisability of making available a total sum of $125,000,000 for the conversion to motor power of existing steamers of the United States merchant marine, and for the building of new motorships. It is pleasing to note the broadminded spirit shown by the Sun Shipbuilding Company, who in addition to inviting a large number of shipping men, extended invitations to representatives of manufacturers of several other makers of Diesel engines.

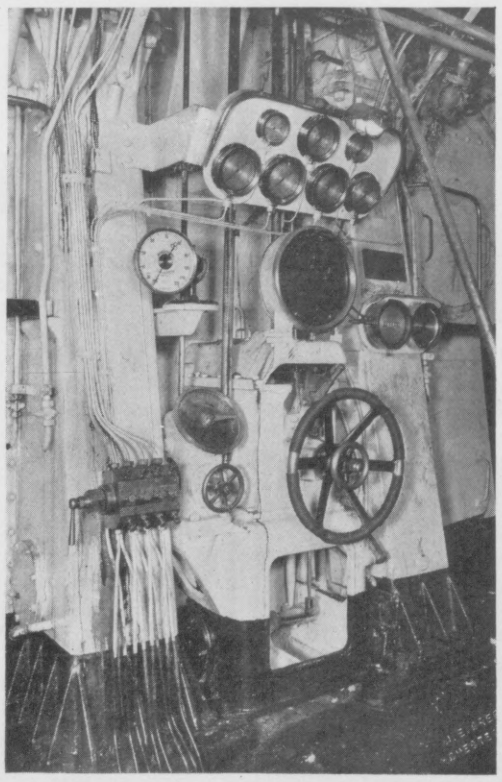
The CHALLENGER is a shelter-deck freighter of 11,620 tons d.w., and is an excellent hull built in 1919 at the Bethlehem Shipbuilding Corp's, Alameda, Calif., plant, for the U. S. Shipping Board. Her general dimensions are as follows—

Name of ship	CHALLENGER
Displacement, loaded	15,930 tons
Displacement, light	4,310 tons
Cubic capacity of holds and between decks	550,000 cu. ft.
Cubic capacity of deep tank	33.530 tons
Weight of machinery	370 tons
Length of machinery space	50′
Fresh-water capacity	145 tons
Power	2,740 s. h. p. or 3,200 i. h. p.
Engine speed	77 to 90 r. p. m.
Ship's speed	10½ knots
Propeller	17″ diam. by 16′ 6″ pitch, 98 sq. ft. area
Daily fuel—consumption at sea	84 bbls.
Daily fuel—consumption in port	10 bbls.
Lubricating oil—consumption	18 gals. per day
Engine-room staff	11 men
Type of deck machinery	Electric
Cruising radius	99 days
Builders of hull	Bethlehem S. B. Co.
Builders of Diesel engines	Sun S. B. Co.
Type of engine	2-cycle O. P. Sun-Doxford
Cylinder bore and stroke	22¾″ x twice 45½″
No. of cylinders	6

The steam propelling-machinery with which she was launched consisted of—

1-G. E. Curtis, 5-stage geared-turbine of 2,400 s. h. p. and 3,500 R. P. M. at turbine shaft reduced to 90 r. p. m. at the propeller.

3-14′ 9″ x 11′ 0″ Scotch boilers of 2,605 sq. ft. heating surface each. Working pressure 210 lbs.



Controls of the main engine. Simple interlocking devices make false moves impossible.

This steam equipment had been removed and replaced by a Sun-Doxford main oil-engine, and Worthington-Westinghouse auxiliaries. It is remarkable to note that the main engine had not even been assembled before being placed in the ship, so that anything like a shop test was never even thought of. In spite of that they functioned without a hitch and stood every test which it is possible to make in the course of an ordinary sea-trial. Everyone aboard admired the general performance, smooth running, and flexibility of the power plant, and as stated there were personalities on the ship who represent a number of the Sun Yard's strongest competitors. Their action in making these invitations is in line with the broad policy that has always characterized this Company.

Naturally the first objects that aroused the interest of the visitors was the deck machinery, which caught everyone's eye because of the neatness of its appearance and the fitness that spoke from every feature of it. Characteristically of generally accepted practise in equipping modern motorships, electric drive was applied through during the process of converting the CHALLENGER from steam to oil engine power. The American Engineering Company of Philadelphia have had a good many years of experience in fitting-out motorships and the product which they furnished for this ship certainly showed it. In their winches they have combined accessibility with watertightness and low cost with stamina.

Westinghouse marine motors and controllers showing a high state of development have been supplied throughout. They are so built and installed that the ship can take on heavy deck seas for days at a time without in the slightest impairing their operating qualities.

The A. E. Co. electric windlass is a reconstructed machine, rebuilt, retaining the present mechanical parts originally installed for the steam windlass, with the addition of a 45 H.P. Westinghouse electric motor, driving the original crankshaft through

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brass bevel and spur gears. To insure rigidity and perfect alignment, the motor is mounted on an extended bedplate bolted against the present windlass bedplate. Since only the space between the hawse pipes is required for this, no valuable deck space is taken up, yet every part is always accessible for inspection. Operation of the motor is accomplished through a control panel by means of a master switch conveniently located.

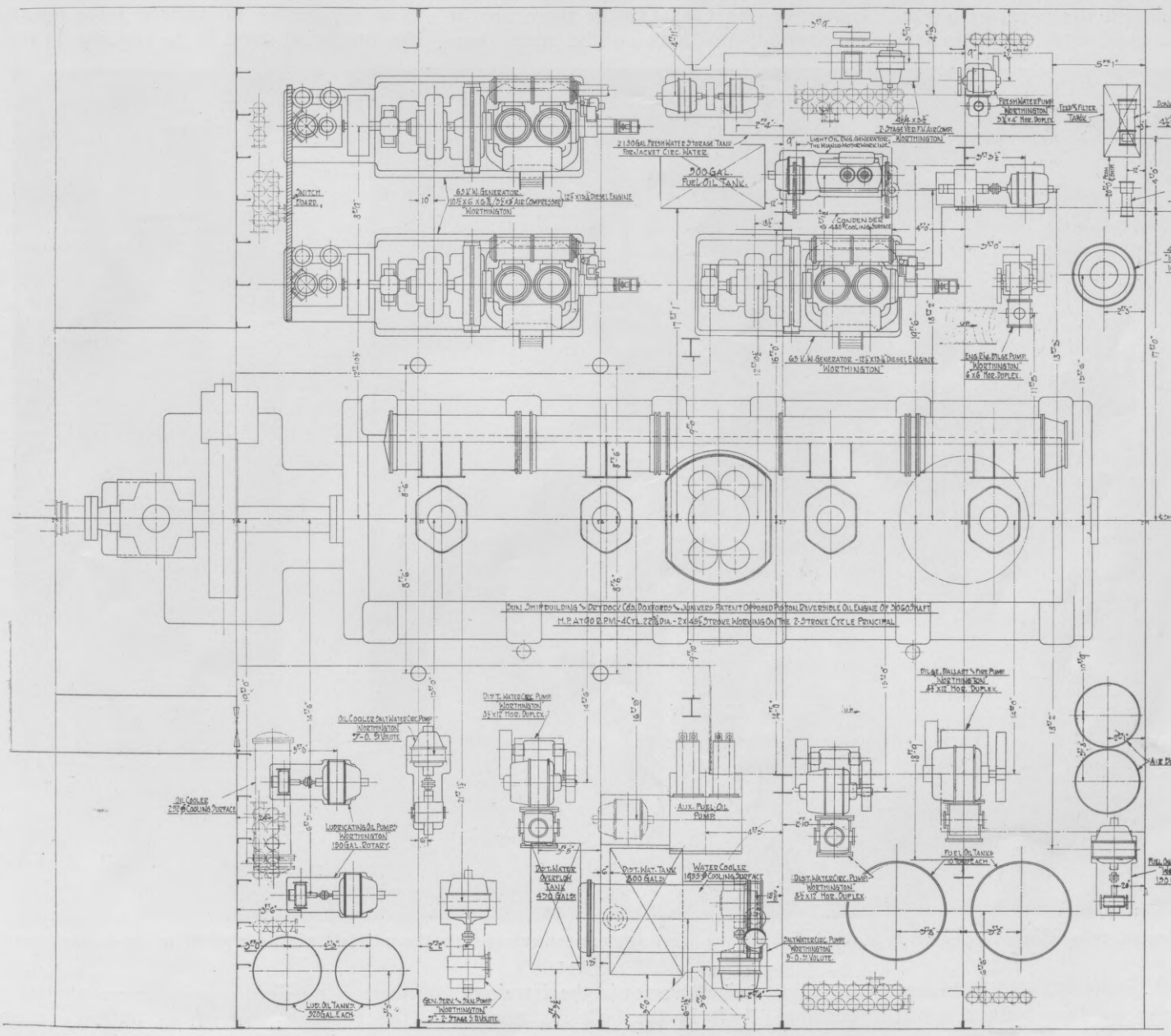
Furnished by the same company is the electro-hydraulic steering gear, which consists of two rams and hydraulic cylinders located athwartships and connected to the rudder stock through a tiller and trunnion. Lubricating oil actuated by a variable stroke Westinghouse-driven Hele-Shaw pump is the hydraulic medium employed. The same telemotor which has been so thoroughly worked out for steam steering-gears establishes connection with the pilot-house and is connected through a differential gear to the control spindle of the Hele-Shaw pump. The latter is a variable stroke and capacity pump operated in one direction at a constant speed and the delivery to the respective cylinders giving the desired movement of the rudder is controlled by the change in the stroke of the pump operated by the hydraulic telemotor from the pilot house. Stoppage of the pump and consequently of the rams is assured by this differential gear as soon as the rudder reaches the position called for by the man at the wheel. Since the hydraulic steering-gear proper as well as the pump are working in lubricating oil, they require no attention while in service. The oil is such that it can be used in all the climates in which the ship can operate.

Electric winches of a compact design have also been furnished by the American Engineering Company; they are of the single drum type in which the winch head is mounted on the drum shaft, the latter being driven through spur gears by a Westinghouse electric motor. Since the shaft bearings and housings are cast integral with the bedplate on which the motor is mounted, the entire machine becomes a self-contained unit. It has a rope speed of 250 ft. per minute and a rope pull of 3,500 lbs.

For heavy service there is also a double-geared winch generally similar to the machine just described, but it can be operated at two speeds and is equipped with outboard bearings for an extended drum shaft carrying two winch heads. It has a capacity of 5 tons at 80 ft. per minute or 2½ tons at 160 ft. per minute.

When the load is sufficiently heavy to pull the slack out of the winch ropes and drop of its own weight on the pier or into the hatch, the Westinghouse deck-winch motors, due to dynamic braking, generates electricity which feeds back into the circuit for supplying current for the peak loads on the other winches. During the trial trip of the CHALLENGER such a test was made with a winch lifting a 7,000 pound load and 20 amperes of current was generated by the motor on the downward swing of the load.

The CHALLENGER is moored and warped by an electric capstan of the gypsy type having a barrel keyed to the vertical shaft, which is driven through worm and spur gearing by an enclosed water-tight Westinghouse motor. As these elements are mounted on a common bedplate, the machine is entirely self-contained. Continuous automatic lubrication is assured because of the fact that the gearing runs in a sealed casing partially filled with oil. The capacity is 10,500 lbs. at a speed of 30 ft. per minute. Since the worm-and-wheel are so proportioned as to be self-locking, no electric brake is required on the motor and


2130 GAL FRESH WATER STORAGE TANK FOR JACKET CIRC. WATER
200 GAL FUEL OIL TANK
65 K.W. GENERATOR 125 K.V.A. DIESEL ENGINE "NORTHINGTON"
65 K.W. GENERATOR - 125 K.V.A. DIESEL ENGINE "NORTHINGTON"
SWITCH BOARD
FRESH WATER PUMP "NORTHINGTON" 5"X 4" HOR. DUPLEX
TEES & FILTER TANK
DONKEY BOILER FEED PUMP "NORTHINGTON" 4½"X 2½"X 4" HOR. PISTON. (STEAM)
FUEL OIL SERVICE PUMP "NORTHINGTON" 3"X 2"X 3" HOR. PISTON. (STEAM)
4'-6" X 4'-6" VERTICAL DONKEY BOILER. INTERNATIONAL BOILER WORKS CO. 1800 SQ. FT. HEATING SURFACE.
ENG. ROOM BILGE PUMP "NORTHINGTON" 6"X 6" HOR. DUPLEX.
SUN SHIPBUILDING & DRYDOCK CO'S DOXFORD'S UNIVERD PATENT OPPOSED PISTON REVERSIBLE OIL ENGINE OF 2640 S.H.P.
H.P. AT 90 R.P.M. - 4 CYL. 22½" DIA. - 2X 45" STROKE WORKING ON THE 2-STROKE CYCLE PRINCIPAL
BILGE, BALLAST & TANK PUMP "NORTHINGTON" 4"X 12" HOR. DUPLEX
DIST. WATER & CIRC. PUMP "NORTHINGTON" 3½"X 12" HOR. DUPLEX
OIL COOLER SALT WATER CIRC. PUMP "NORTHINGTON" 7"-0" SQ. VOLUTE
OIL COOLER 270 SQ. FT. COOLING SURFACE
LUBRICATING OIL PUMP "NORTHINGTON" 120 GAL. ROTARY
DIST. WATER & CIRC. PUMP "NORTHINGTON" 3½"X 12" HOR. DUPLEX
AUX. FUEL OIL PUMP
DIST. WATER OVERFLOW TANK 420 GALS.
DIST. WAT. TANK 200 GALS.
WATER COOLER 1855 SQ. FT. COOLING SURFACE
DIST. WATER & CIRC. PUMP "NORTHINGTON" 8½"X 12" HOR. DUPLEX
SALT WATER CIRC. PUMP "NORTHINGTON" 9"-0" VOLUTE
AUX. BOTTLES
FUEL OIL TANKS 10 TONS EACH
FUEL OIL TRANSFER PUMP "NORTHINGTON" 120 GAL. ROTARY
FUEL OIL TANKS 300 GAL. EACH
GEN. SERV. & SAN. PUMP "NORTHINGTON" 7"-2" STAGE S. DUPLEX

Plan of engine-room lay-out of the motorship "Challenger" showing her Sun-Doxford 2,740 s.h.p. main engine, Worthington auxiliary oil-engine, Mianus-General Electric emergency lighting set and the various pumps.

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a considerable simplification of the electric controlling parts is thereby effected. Excellent equipment has been furnished by the American Engineering Company throughout.

There are few cargo vessels afloat which enjoy the distinction of being steered by means of a gyroscopic compass and it is not surprising to find that the same progressive spirit which sponsors the installation of oil engines should also be responsible for up-to-date methods of navigation. Owing to the fact that the gyro-compass is entirely unaffected by magnetic or other deviations, it effects pronounced economies by shortening routes. The Sperry Gyroscope Company have dominated the naval gyro-compass field for a good many years and the merchant vessel instrument which they are furnishing is also far from being a novelty on the market.

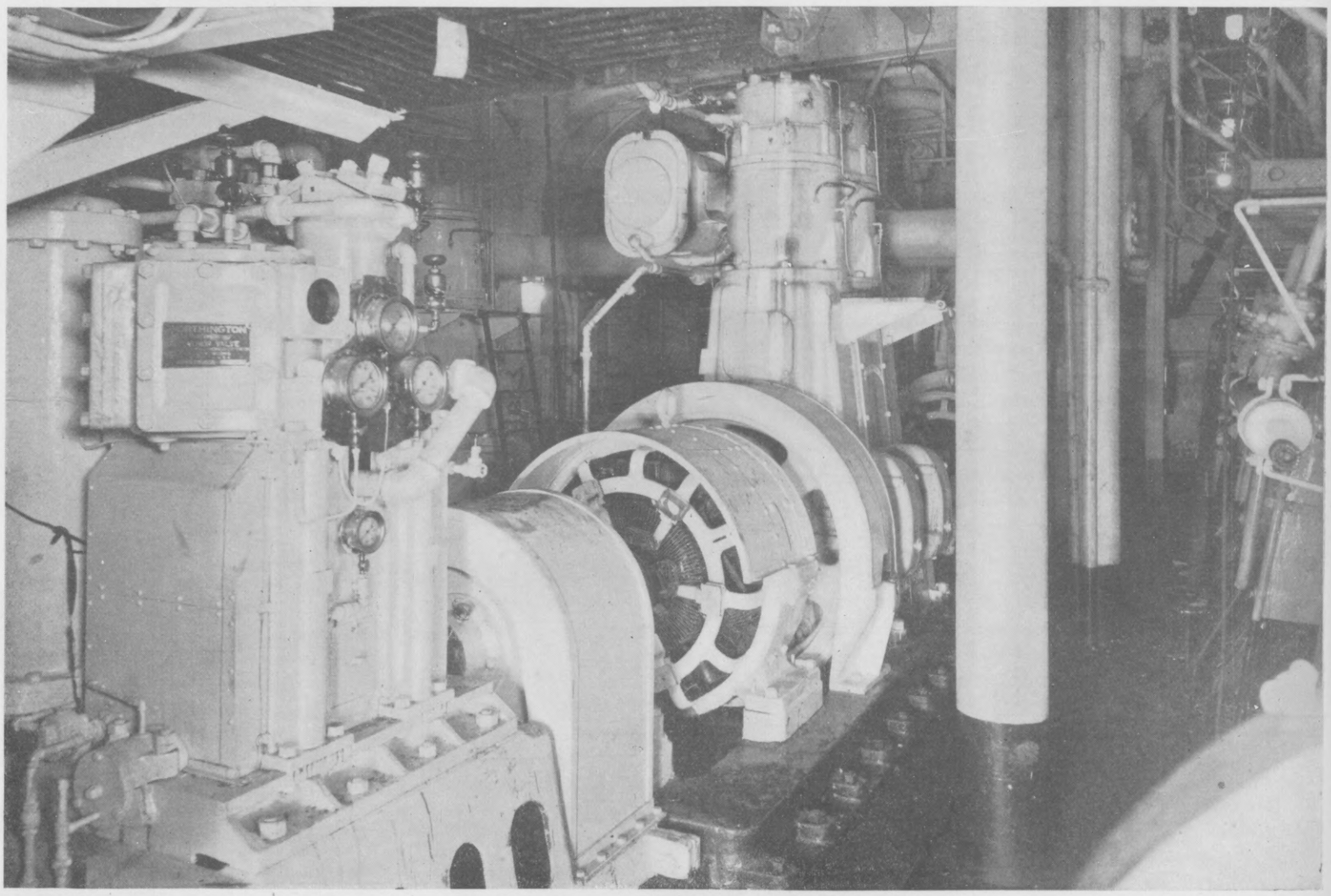
The main propelling-unit consists of a Sun-built Doxford opposed-piston, airless-injection oil engine developing 3,200 i.h.p. at 77 r.p.m. and served with electrically driven auxiliaries. It transmits power to the ship through the medium of a Kingsbury thrust-bearing, well known for its simplicity, efficiency, and the amazing economy of space that is realized by its use. Plenty of space remained in the engine-room after the entire installation had been accommodated between the same bulkheads that had previously enclosed both turbines and boilers of the discarded steam equipment. The main engine has four working-cylinders bored out to 22¾″ in which move two pistons having a stroke of 45½″ each. Although the piston speed is only 586 ft. per minute, the pistons actually approach and recede from each other with a mean velocity of twice that amount, namely, 1,172 ft. per minute and their total stroke is *seven feet and seven inches.* A full-grown man with a child sitting on his shoulders could stand erect on the lower piston while on its lower dead center without letting the child's head touch the upper piston, as the addition of the clearance space brings the extreme distance between pistons to more than eight feet.

In this 2,740 shaft h.p. Sun-Doxford engine of the CHALLENGER there are no gas-pressure reactions on the main bearings, no tension stresses in the framing, no bending loads in the bedplate, negligible shaking forces due to inertia, and no cylinder heads. Owing to the fact that there are two pistons working in each cylinder barrel, twice as much displacement is secured as in ordinary machines of the same bore and stroke of the single acting type.

These remarkable results, and the development of 685 b.h.p. on a bore-and-stroke basis which in the usual four-cycle engine would yield at the most 150 h.p. per cylinder, have been attained by a thorough-going workout of the two-cycle principle as applied to the Doxford-Keller design of the well-known Junkers system. The distinguishing features of this arrangement are the use of a set of three-throw cranks between each pair of main bearings and a pair of oppositely moving pistons of which one is coupled by means of a pair of rods with the outer two cranks standing at the same phase and the other is linked to the center crank standing 180 degrees away from the outer cranks. When the middle one is at the bottom dead center, the outer cranks are at the top and a rotation of the crankshaft then produces an upward motion of the lower piston and a downward movement of the upper piston. Whatever air has been caught between the two is then compressed until both pistons have reached the opposite dead-centers.

Since the pressure load is borne alike by both pistons, no unbalanced force remains for producing stress in the framing, in fact, there is no fixed member corresponding to the cylinder head of an ordinary engine against which a pressure load could react. The reaction itself is transmitted through rods to the crank. Except for negligible connecting-rod angularities, equal and opposite forces must therefore always be applied to the crank-arm and there can be no force left for producing pressure on the main bearings.

Exactly the same considerations apply to the inertia forces and the only static reactions of any consequence that can be discovered anywhere are the hoop-stresses in the cylinders and the side forces at the crosshead shoes. There was a tendency, however, on the part of the early German originators of this engine to lay too much stress on these facts and they produced a



Three Worthington, twin-cylinder, two-cycle type oil-engines driving Westinghouse generators form the principal auxiliary power in the engine-room of the "Challenger".

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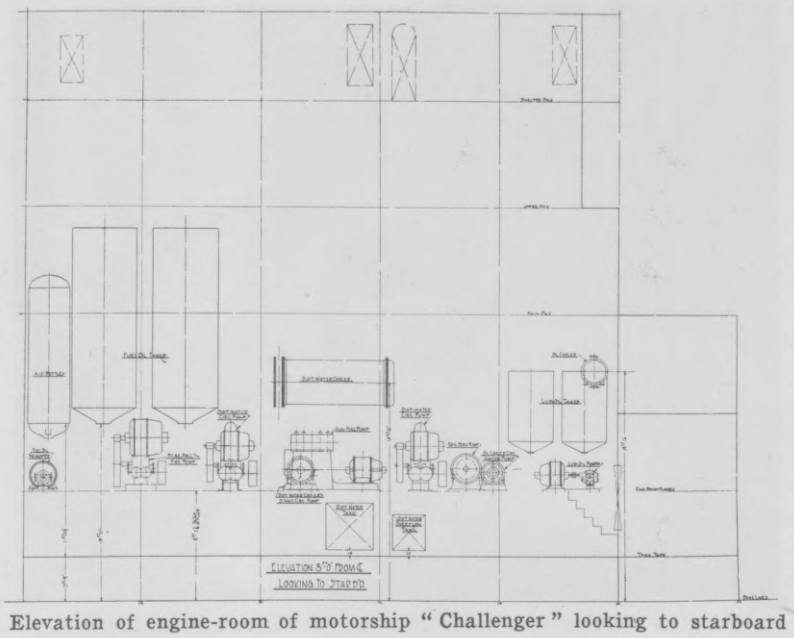
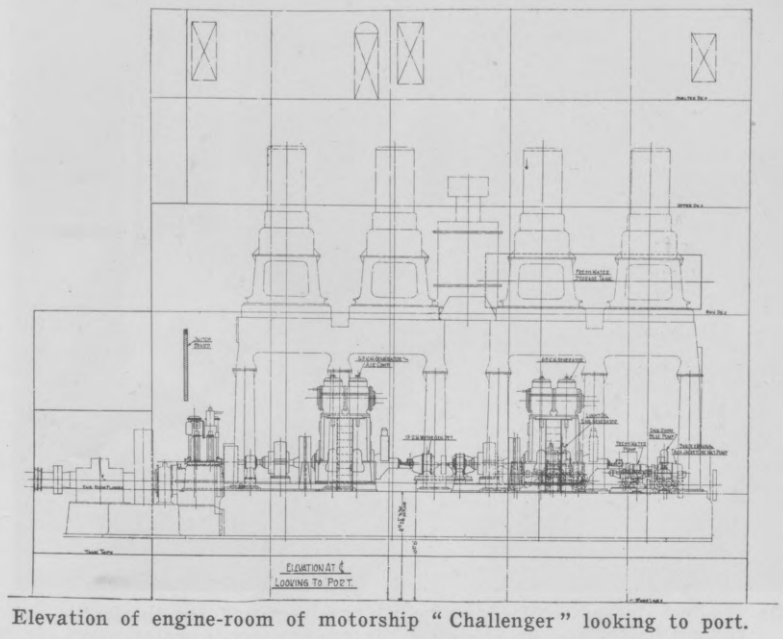


Elevation of engine-room of motorship " Challenger " looking to starboard



Elevation of engine-room of motorship " Challenger " looking to port.

machine which lacked the *sine qua non* of oil engine success—rigidity. There are a multitude of forces and deflections in oil engines—varying according to the design—of which the keenest reasoning cannot always take into account, but which in most cases must be guarded against by a more or less general and universal provision of deep and massive metal sections. Only a glance at the Sun-Doxford engine makes it apparent that the designers of this machine have given ungrudging recognition to this important lesson of experience.

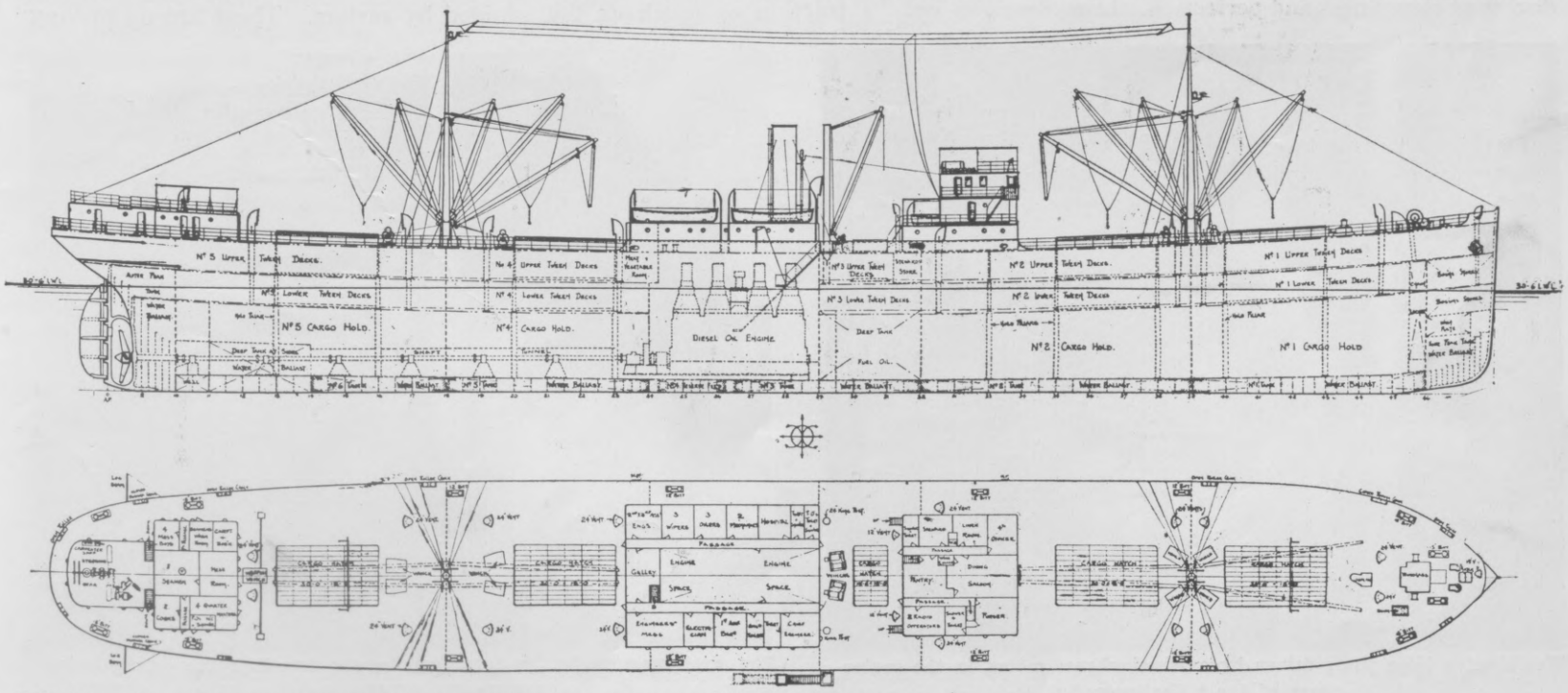
With the Sun-Doxford design all the main direct stresses are taken up by forged members mathematically proportioned with a high degree of certainty. Of these forgings, only the central connecting rod is subject to compression and the side-rods for the upper piston are always in tension. Since they take hold through a toggle beam, they are insured at all times against unequal load distribution and it is impossible for them to produce cocking in the guides of the upper piston.

Although, as has been stated, none but nominal loads are applied to the stationary parts of the engine, its framing exhibits the same ruggedness and rigidity as though it had to withstand the same forces that must be allowed for in the usual designs. The bed-plate is of deep section and is well adapted for resisting hull-deflections. This is a point which cannot be over-emphasized in the case of engines wherein the bed-plate takes up working loads, and its careful observance which we find here in an engine structure not exposed to these loads, is highly to be commended. There are four massive buttress-like columns under each cylinder, four over each main bearing.

As regards details of operation it is interesting to note that the pistons are steel capped and maintained at a temperature high enough to further combustion, but not so high that they might be damaged. Compression is low, being only 320 lbs. per sq. in., a figure that compares very favorably with those frequently used in oil engines not equipped with external ignition devices. Airless injection of an efficient high-pressure type is used and the cylinder jackets are steam heated by a miniature oil-fired boiler at starting and during manoeuvers. Perhaps no better testimony of the success of these arrangements can be had than that Mexican residual oil having a heating value of 17,600 b.t.u. and an asphalt content of 22 per cent can be cleanly burned. The oil on the trials was the Sun Co's Texas fuel.

Cylinder liners having a wall thickness of only one inch are used and they are provided with the necessary strength by means of ribbing, which also improves the transmission of heat. The tops of the ribs, according to the latest practice, are machined cylindrical and allow the liner to be made a tight fit in the water jacket over a length of about three feet and to permit of transmitting a part of the hoop stress to the outer jacket.

Inherent in the construction are excellence in the shape of the combustion space and an elegance of the scavenging process which we have not yet seen in any other design of two-cycle oil engine. The combustion volume is really



Inboard profile and deck plan of the 11,850 ton dw. motorship " Challenger '. Arrangement of electric deck-winches can be seen on the plan.

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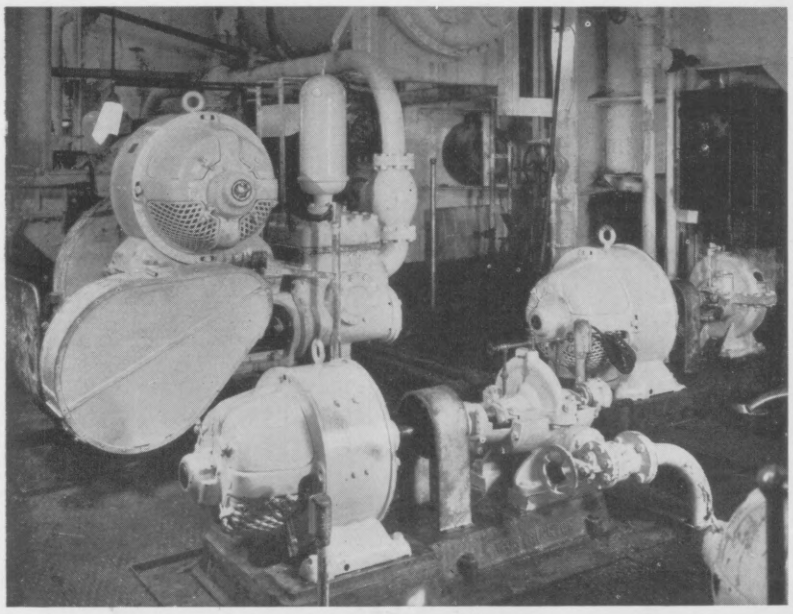
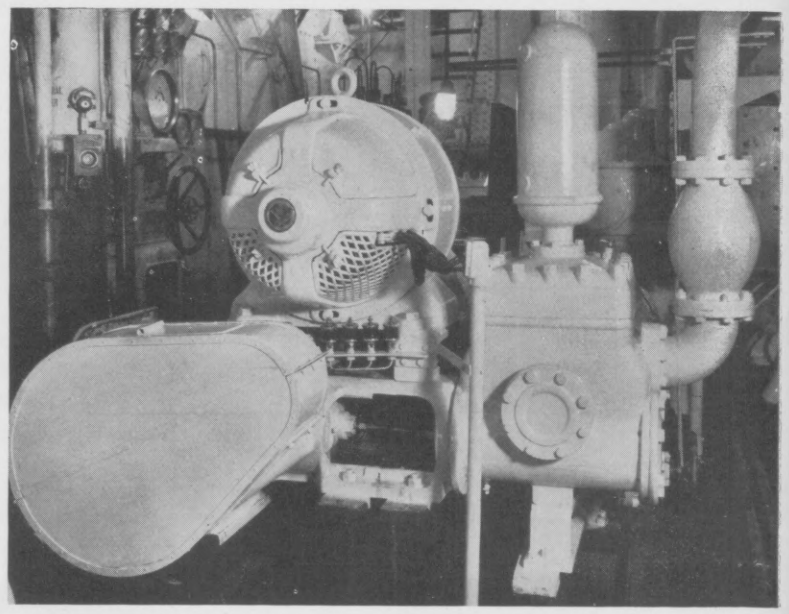


On the left, jacket cooling pump; in the foreground the lubricating-oil cooling pump, and on the right the general-service water pump.



Worthington-Westinghouse pump supplying cooling water to the cylinder jackets of the Sun-Doxford engine.

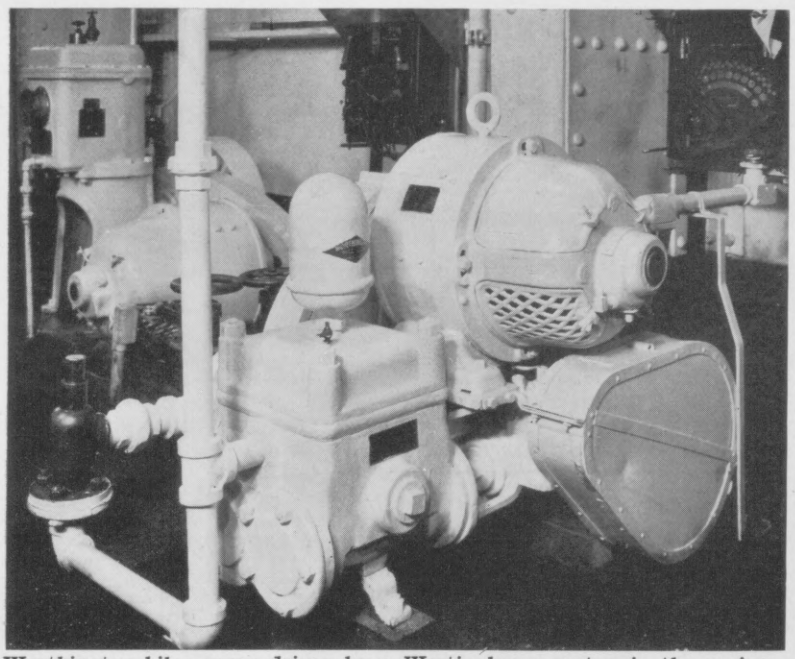
the space by which the pistons miss touching each other and has a shape ideally suited to the combustion of fuel. Inlet ports having an unusually generous area are cut near the bottom dead center of the lower piston and extend completely around the circumference, while somewhat higher exhaust ports are similarly located near the top. Towards the end of the pistons' outward travel, the earlier opening of the exhaust ports permits the pressure in the cylinder to blow down, whereupon admission of air through the inlet openings commences. Owing to the fact that the entrance of the air is completely circumferential and that it can travel the length of the cylinder practically as a solid column without having to double back on itself, a rare degree of perfection in the scavenging process is attained. It amounts, in effect, to uniflow scavenging.

The practical consequences of this are that a very complete substitution of fresh air for burnt gases is made, that low-grade fuel can be consumed with a high degree of cleanliness and perfection. Low scavenging-air pressure can be employed, power-consumption of the scavenging pump reduced and certain operation, even with greatly reduced scavenging pressure, is made possible at remarkably low revolutions per minute. Absolutely steady running at 21 r.p.m. was obtained during the trials and the 3,000 h.p. engine responded to all manoeuvers as though it had been a tug-boat engine.

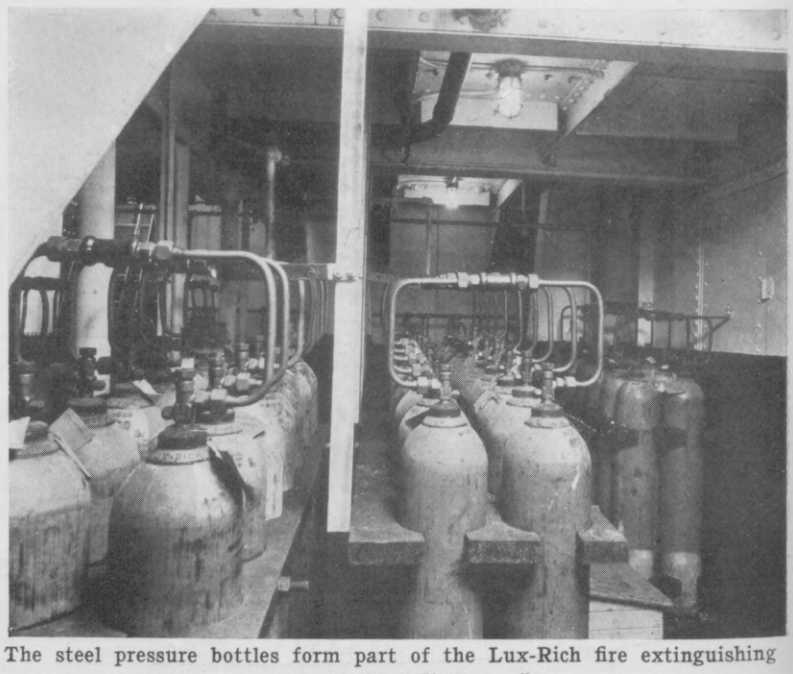
It is evident from the foregoing that the replacement of the reciprocating scavenging pump on the engine by an independent electrically driven turbo-blower or scavenging-pump, such as will be made in the 3,100 i.h.p. Henry Ford motorships' engines shortly to be built at the Sun plant is not caused by any defects attributable to the engine under consideration. The reason for this substitution are of a business rather than an engineering nature. Ten per cent. more power will be realized on the engine shaft and its overall length will be shortened by something like four feet, not to mention that a high-speed turbo-blower—if used—weighs only a fraction as much as the reciprocating pump. The blower has only a single moving part and is valveless.

Lubrication of the cylinders is by a battery of Richardson-Phoenix lubricators, which are too well-known to need description at this time.

Main auxiliary power on the CHALLENGER is produced by three 100 b.h.p. Worthington heavy-oil engines direct connected to 65 kw. Westinghouse 220-volt generators, two of these generating sets being also clutch-connected to Worthington 2-stage starting air compressors. The engines are of the well-known two-cycle valveless type in which camshafts and compressors are also conspicuous by their absence. An excellent airless-injection system used in conjunction with a pre-combustion chamber makes possible the use of low grades of fuel, in fact of the same fuel that is used in the main engine. The use of crossheads makes possible an absolute separation of working cylinders from the driving mechanism so that the force feed lubrication system on which they are run is never in danger of being fouled by carbon. There are no moving



Worthington bilge pump driven by a Westinghouse motor, in the engine-room of the "Challenger".



The steel pressure bottles form part of the Lux-Rich fire extinguishing system of the "Challenge."

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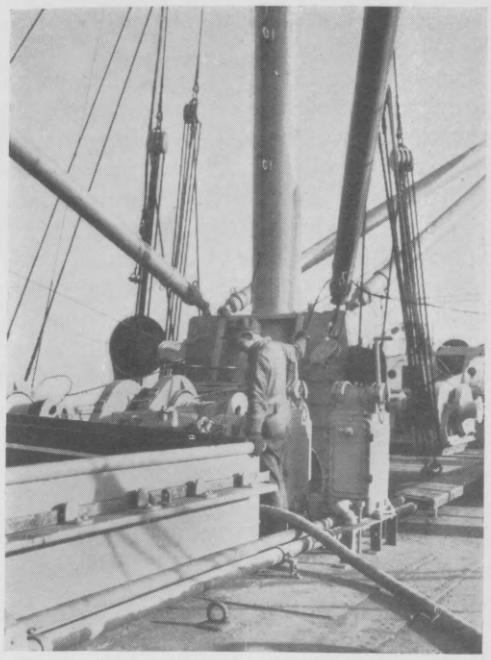


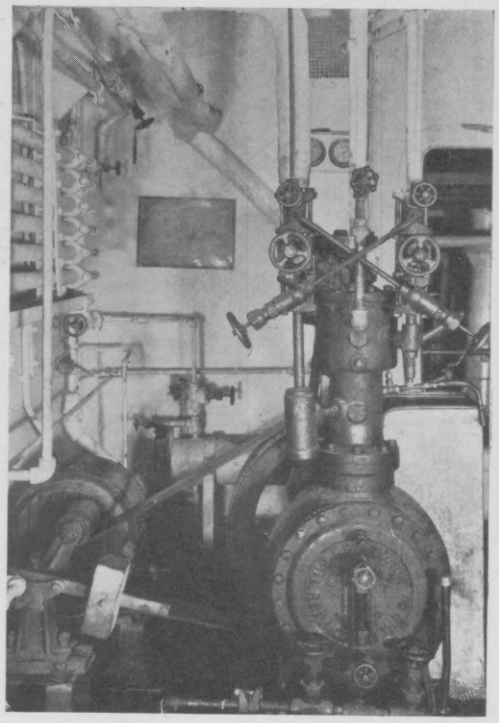
The control for 10 American Engineering-built Westinghouse motor-driven water tight deck winches are so located that the operator can easily see into the holds of the "Challenger" as he is raising and lowering the cargo.

parts except the fly-wheel visible on the exterior of these engines and all their functions, including lubrication, air starting, and many others are so reduced to automatic positive operation that their manipulation is actually simpler than that of a steam generating set.

The Worthington two-stage air compressors that may also be directly driven from these units have a capacity of 150 cu. ft. of free air each against a maximum pressure of 700 lbs. per sq. in. On them too there are crossheads and force feed lubrication is applied to the driving members. Laidlaw feather-valves giving maximum area at a minimum pressure difference are fitted. Particularly interesting is the use of a Cutler-Hammer type H magnetic clutch, eliminating as it does the motor and switchboard complications that would have accompanied the usual electric drive. The operation of the magnetic clutch is the merest child's play compared to the manipulations of first putting the electric generating set on the board and then throwing in a driving motor for the compressor. Because of its simplicity and ruggedness, no better selection than the Cutler-Hammer clutch could have been made and the Sun & Worthington engineers deserve credit for the ingenuity and foresight with which they have worked out this auxiliary compressor drive.

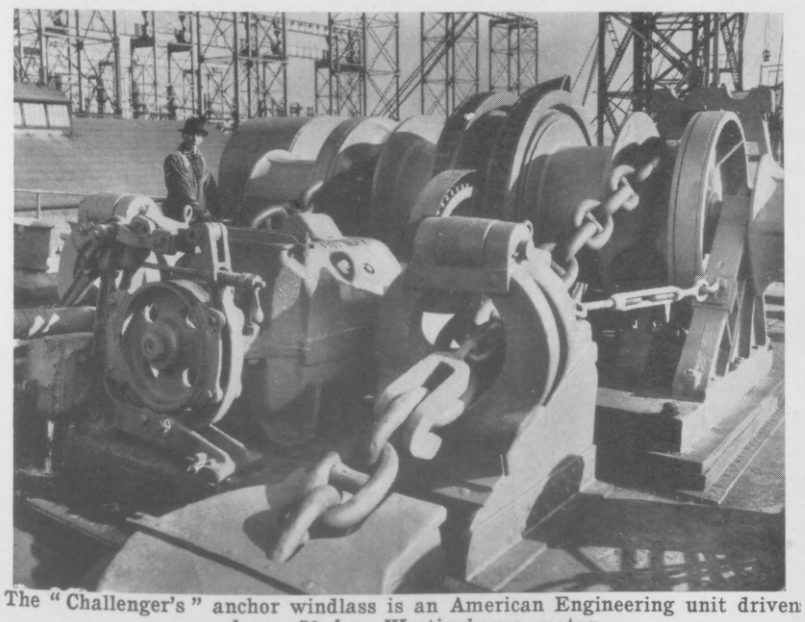
An emergency set which is also the result of careful selection consists of a Mianus oil-engine direct connected to a 10-kw. Westinghouse 110-volt generator. This engine has a special type of precombustion chamber somewhat similar to the one already referred to in connection with the Worthington machines and possesses the important property of being able to start without the use of a torch and without so much as a pound of compressed air being present in the starting tanks. The cylinders of this Mianus engine are lubricated by a McCord force-feed oiler. Another part of the equipment consists of a small 8-cu. ft. Worthington 2-stage air-compressor direct connected to a Westinghouse 7½ h.p. 115-volt motor. In cases of the rare contingency that starting air should be lost, the Mianus engine can instantly be put in service to furnish current for the little compressor, which, being designed for maximum delivery pressure of 700 lbs. per sq. in., can at once begin to replenish the starting tanks. The emergency compressor is of compact design and fitted with valves of a surprisingly simple type, so that a failure of the emergency air supply is practically ruled out. Compared with the operation of firing up a donkey boiler and of getting a steam compressing set under way, the ease and promptness with which air can be raised with the Mianus-Worthington outfit are striking indeed.

A separate high-pressure fuel-pump used for starting the main engine is also available as a stand by in case the built-in pump should be prevented from operating. It was built at the Sun yard along the same excellent lines as the main engine pump.

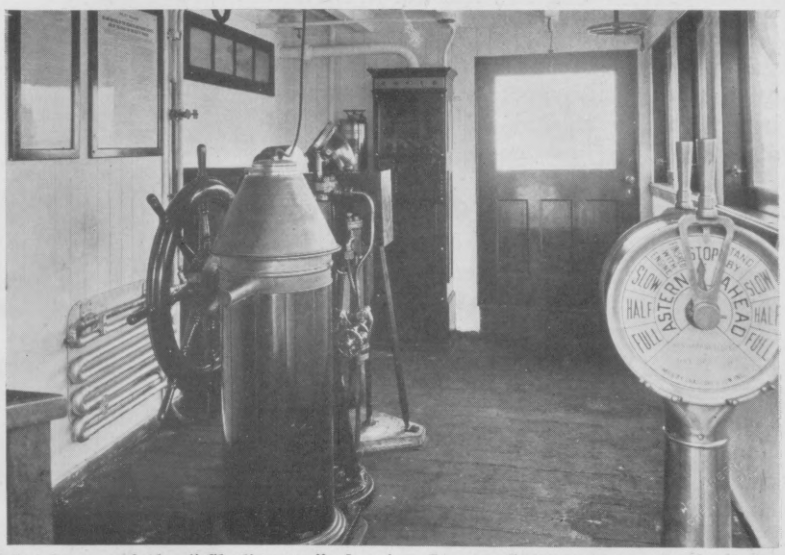


This Brunswick-Kroeschell compressor set is one of the extremely few units of the original auxiliary machinery that was retained when converting the "Challenger."

No force-feed engine is complete without effective means for ridding the lubricating oil not only of minute solids, but also of water. Although there are many good purifiers of the filter type on the market, the mathematical precision and certainty with which the centrifugal separator separates the clear oil from all liquid or solid foreign matter seems to be having a compelling effect on the judgments of those vitally interested. Water, and especially salt water, is perhaps the best known agency for running up stupendous repair bills on force-feed lubrication jobs of all sizes. As there is available so completely effective a safeguard as the centrifugal purifier, it is almost inevitable that this apparatus will soon be recognized as standard equipment for motorships large or small. By installing a De Laval oil purifier requiring only a 2 h.p. General Electric motor to drive it, the Sun engineers have given additional



The "Challenger's" anchor windlass is an American Engineering unit driven by a 50 h.p. Westinghouse motor.



Pilot-house of the "Challenger" showing Sperry Gyro compas, standard Cory binacle and Cory engine-room signaling indicators. In the background can be seen the sight detectors for the Lux-Rich fire detecting and extinguishing apparatus.

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evidence that they are thoroughly abreast of the times.

Other first-class equipment such as is frequently found on motorships is a 2-ton Brunswick ice machine driven by a 5 h.p. 220-volt Diehl motor; also a 7½ h.p. Westinghouse D.C. motor for running the machine shop and a 15 kw. motor-generator set for the lighting system.

Worthington pumping equipment for a variety of engine room services is installed with Westinghouse motor drive as follows:—

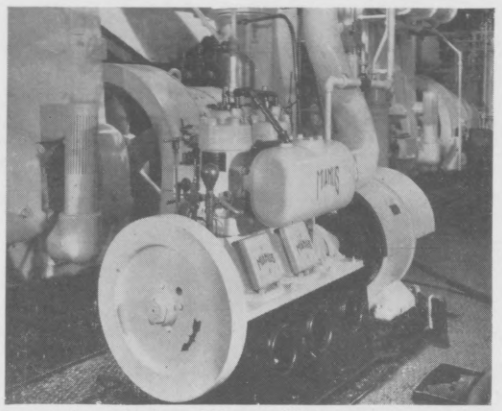
2 550 G.P.M. Fresh Water Reriprocating Pumps.
1 550 G.P.M. Salt Water Centrifugal Circulating Pump.
1 150 G.P.M. Fuel Oil Rotary Transfer Pump.
1 550 G.P.M. Bilge, Ballast, and Fire Reciprocating Pump.
1 125 G.P.M. Engine Room Reciprocating Bilge Pump.
1 250 G.P.M. Lubricating Oil Cooler Centrifugal Circulating Pump.
1 200 G.P.M. General Service Centrifugal Pump.
1 150 G.P.M. Sanitary and Auxiliary Engine Centrifugal Circulating Pump.
1 50 G.P.M. Fresh Water Reciprocating Pump. Steam or Air Driven
1 Donker Boiler Feed Pump.
1 Horizontal Duplex Fuel Oil Service Pump.

An interesting product of the Sun Shipyard's Engineering Department is an exhaust-gas boiler of 1,046 sq. ft. heating surface designed to operate at 125 lbs. per sq. in. for recovering waste heat from the main engine while the latter is running under full power. During manoeuvers or stoppage this boiler is kept in service by means of fuel-oil burning equipment served by the Worthington pump already listed. Steam from this boiler is used for general heating purposes and for maintaining fuel-oil and main engine cylinder-jackets at the right operating temperatures. As there is also a separate oil-fired boiler for these purposes, ample stand-by heating facilities are available.

Further Sun products are:

1 300 sq. ft. Auxiliary Condenser.
2 Starting-Air Tanks of 110 cu. ft. each at 700 lbs. per sq. in.
2 10-Ton Daily Service and Settling Tanks.
2 520-gal. Engine Lubricating Oil Tanks.
1 Lubricating-Oil Cooler of 252 sq. ft. Surface.
1 Distilled-Water Cooler of 2,000 sq. ft. Surface.

It might naturally be expected that a ship so well equipped as the CHALLENGER must necessarily represent a correspondingly high capital investment and although the first cost is higher than that of the equivalent steamship, the outlay **per ton of actual freight carrying capacity** is so nearly alike that the Doxford ship makes up the difference by virtue of reduced fuel costs in the course of a few voyages. Our British contemporary FAIRPLAY gives some comparative figures on a smaller vessel built by Doxfords that have an indirect bearing on Sun-Doxford engined vessels. The interesting point is made that comparative costs of steam and motorships should be figured not on the basis of total deadweight tons, but on deadweight capacity **minus** bunkers, a method obviously rational.



The twin-cylinder Mianus-Westinghouse oil-engine generating set in the engine-room of the "Challenger."

DOXFORD 10-KNOT MOTOR SHIP

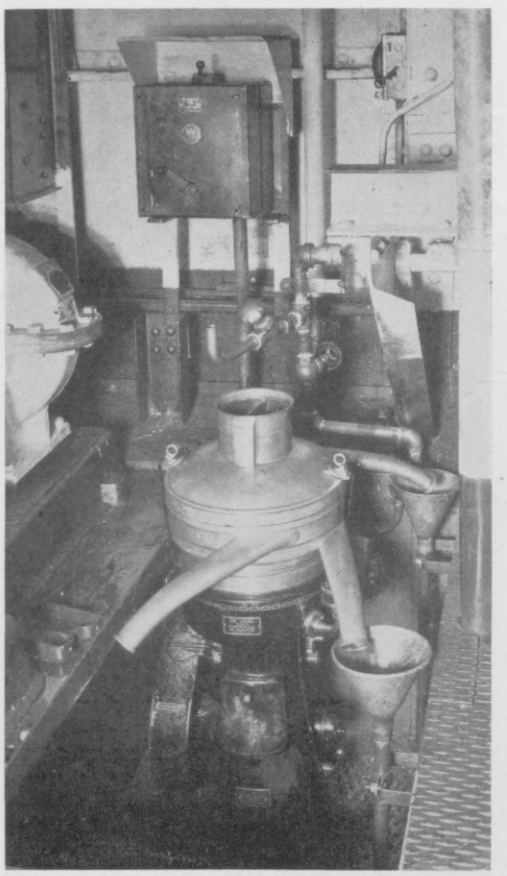
Operating Costs SS. Cargo-Vessel, Type Open Shelter Deck

(Independent of Fuel-oil Costs)
Dimensions, 375′ 0″ x 52′ 0″ x 28′ 3″ mld.
Load Draft, 25′ 0″

	Coal-fired steam	Oil-fired steam	Doxford Oil Engine
Cost of Vessel	$404,550	$420,000	$533,000
Deadweight (cargo and bunkers)	7,025 tons	7,920 tons	8,000 tons
Cargo d.w. Cardiff to Buenos Aires	6,045 tons	7,095 tons	7,400 tons
Cargo d. w. Buenos Aires to Cardiff	7,045 tons	7,115 tons	7,670 tons
Cost per Ton of Cargo, going	$66.90	$59.20	$71.90
Cost per ton of Cargo, return	$57.40	$59.10	$69.40
Average Cost per Ton of Cargo actually carried	$62.15	$59.15	$70.65

As these figures have been obtained by the use of a nominal exchange rate, no importance is attached to their absolute amount, but that does not alter their comparative significance in any way. The benefit of the lower fuel-consumption of the motorship is not included.

Just a word by way of conclusion.



The De Laval centrifugal oil-purifier installed in the engine-room of the "Challenger."

Progressiveness on the part of the Sun Shipbuilding and Dry Dock Company has already been attested by the fact that they discarded the steam auxiliaries in the design of their first two motorships in favor of oil-engine-electric auxiliaries as installed in their subsequent motor vessels. In view of the fact that they are among the very few American oil-engine builders who are able to put 3,000 b.h.p. on a single shaft in a limited space, they appear to have been placed in an unusually strong position by the forthcoming congressional appropriation for the conversion of large single-screw Shipping Board vessels to oil-engine power.

FURNESS WITHY'S LATEST DOXFORD MOTORSHIPS

Of the two 10,000 tons d. w. cargo vessels PACIFIC SHIPPER and PACIFIC TRADER, building at Doxford & Sons yard, Sunderland, for Furness, Withy & Co., the first-named has now been launched. The vessels are 420 ft. by 58 ft. by 30 ft. 11 in. and will be equipped each with one four-cylinder Doxford oil-engine rated at 2,900 b.h.p., 580 mm. (22.83 in.) bore by twice 1,100 mm. (43.30 in.) stroke when running at 87 revs. per min. As will be remembered the cylinder dimensions of the engine on board the DOMINION MILLER were the same, but owing to the lower propeller speed of 77 revs. per min. their rated horsepower was only about 2,700 s.h.p.

With a view to ensuring the most efficient equipment for handling heavy fuel-oils, which have already been burnt very satisfactorily in Furness Withy's motorship DOMINION MILLER, centrifugal separating machines are to be installed in these new vessels. Centrifuges have, of course, been tried out for dealing with lubricating oil but in this case two machines will be fitted in each vessel for dealing both with lubricating and fuel oil —a plan that MOTORSHIP has been investigating for many months. Heavy asphaltic oils contain impurities and water which should be removed to secure efficient running of the propelling plant. Centrifugal filtration has been considered by some engineers as the most effective treatment prior to supplying the oil to the fuel pumps of the engines.

A further innovation is the installation of a de-gassing plant. The removal of free air from the cooling water and the absence of dissolved gases are considered beneficial. In the Doxford engine the cylinder cooling-spaces are really steam jackets and conditions are somewhat different to that where the discharge water temperature never exceeds 110 degs. Fahr. or thereabouts. It will be interesting to watch the results of such precautionary measures on the cooling spaces of pistons and cylinders, because of their importance on future practice.

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Congress and Steamer Conversions

Thursday, January 10th, 1924

THE committee met at 10.30 o'clock a. m., Hon. William S. Greene (chairman) presiding.

Mr. Edmonds: The meeting is called to consider H. J. Res. 41, which follows:

JOINT RESOLUTION permitting the use of certain funds by the United States Shipping Board.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the United States Shipping Board may, in its discretion, use the construction fund as provided in Section 11 of the merchant marine act of 1920 for the purpose of converting the present-owned ships of the United States into motorships.

My thought in introducing this resolution was that the tremendous strides foreign nations are making in building Diesel boats deserved from us an investigation of the possibility of installing Diesel engines in a lot of these boats.

I am only providing in this resolution that ships that are in good condition can have their boilers and engines taken out and be equipped with Diesel engines, making them Diesel-engined boats which, to-day, are the most economical boats that are running on the seas.

We now have in the fund $75,000,000. That is the general fund created under the Jones bill, setting aside $25,000,000 a year from sales for the purpose of building new ships. Unfortunately, it did not go any further than the building of new ships, and in order to allow them to use this money for conversion, it is necessary to give them the authority, and this resolution gives the authority. And, to my mind, it is imperative that we should do something of this kind, if you desire to stay in the carrying trade particularly with the cargo boats. And even passenger boats, now, are being equipped with Diesel engines. But the economy in operation is so great it would pay you to convert.

While the conversion cost is high, yet, at the same time, the value of the boat is so increased that you can really get the conversion cost out of them. I would figure, if the department would give these contracts in blocks of 10 ships to this yard and 10 ships to that yard, that by making a block conversion the cost of conversion would be about $300,000 for each boat. Most of these boats will require an expenditure anyhow of from $50,000 to $75,000 on them before they can be put into service; that is, if they are tied up at the present time, and the cost to convert to Diesel engine would be about $300,000. So that I believe it would be common sense to take the boats under seven or eight thousand tons and convert them to Diesel boats to-day, which would then bring $50 to $60 a ton. If that is the case, we are giving our shipping men the most economical type of boat and allowing them to compete. Yet we are asking no more than they could build boats of that type for; in fact, it would be a great deal less. I think a new Diesel boat can be constructed to-day for about $80 a ton. I think you will find it is the advisable thing to do and I would like the committee to consider it and it is imperative we should do it at once. We have no excuse, from my investigations, for not doing this at once. These boats can be operated so much cheaper and they can be bought so much cheaper, that it is purely a business proposition to do it.

Mr. Bland: What is the amount on hand now ?

Mr. Edmonds: There is $75,000,000 set aside in that construction loan fund.

I think to put Diesel engines in a hundred of our ships to-day would be a notice to the people of foreign nations we did not propose to back down on our merchant marine.

Testimonies Given Before the Committee on Merchant Marine and Fisheries, House of Representatives, Washington, D. C., Thursday, Jan. 10, 1924

William S. Greene, Chairman

George W. Edmonds.	Ladislas Lazaro.
Frank D. Scott.	Ewin L. Davis.
Wallace H. White, Jr.	Schuyler Otis Bland.
Frederick R. Lehlbach.	Clay Stone Briggs.
Benjamin L. Rosenbloom.	William W. Larsen.
Arthur M. Free.	Tom D. McKeown.
Sid C. Roach.	George W. Lindsay.
Charles Brand.	William M. Croll.
Frank R. Reid.	Jeremiah E. O'Connell.
George M. Wertz.	Dan A. Sutherland.
Robert L. Bacon.	

R. G. de Tonnancour, Clerk.

THE HIGH SPOTS

Owing to the mass of evidence given it is not possible for MOTORSHIP to reproduce the Hearings in full, so we have eliminated all but the high spots of the various testimonies. It is interesting to note the keenness shown by members of the Committee in the subject of Diesel power.

Statement of Admiral W. S. Benson, Member of the United States Shipping Board.

Admiral Benson: I would like to say in the beginning, in regard to what Mr. Edmonds has said on the question of delay, I think you will find that the data you will get from these different gentlemen is such that it will convince you we have reached a stage where it is no longer an experiment we are dealing with, but an accomplished fact. We also, who are studying the situation as far as shipping is concerned, believe and at least we hope, very strongly, we have reached dead low water in the shipping situation and a better condition will prevail and, for that reason, we should be prepared to go into the field of transportation with the best equipped and latest type of ship for that purpose.

To indicate the trend of affairs abroad, the shipbuilding statistics indicate that about 50 per cent of the shipbuilding that is going on in the world to-day is of motorships. We not only want to provide some means for the Shipping Board to convert its ships, but we want particularly to encourage private shipowners, or those who anticipate buying ships, to put Diesel engines in them.

I presented to the Shipping Board and they have finally adopted the policy that we would sell our ships that were suitable for Dieseling purposes to American purchasers at a price which would permit them to put proper Diesel engines and auxiliaries in them and, when they put them in service, they would be at a less capital cost than the same type of ship could be purchased by any of our foreign competitors, so that our American shipowners would have that advantage in the capital cost of ships they were operating.

We have sold some of our ships for as little as $5 a dead-weight ton, with the distinct understanding that the Diesel engine and outfit should be installed in the vessel of a type and general arrangement to meet with the approval of the experts of the board, and we have tried to encourage the various builders of engines. For instance, we have in the Shipping Board one case which I think will illustrate the principle very well, the WILLIAM PENN. The WILLIAM PENN is a large 12,375-dead-weight ton merchant ship. She was not really intended originally or designed originally for Diesel engines, but it was decided to put the Diesel engine in, and the Burmeister & Wain four-cycle Diesel engine was installed by the Cramp's people in the WILLIAM PENN. She has been running steadily from the North Atlantic to the Far East; she has already made four trips, and, although a large ship, she has run without any difficulty whatever. She has averaged about 11½ knots and on a consumption of about 13½ tons of fuel oil daily, and, in port, only a very small amount. One of our ordinary turbine ships of 7,500 or 8,000 tons that will run at 10 or 10½ knots per hour on from 30 to 35 tons of oil a day is a very good performer. So you see the immense economy in the fuel situation.

The WILLIAM PENN, as I say, is now preparing for her fifth trip, I think it is, to the Far East. So far, her engine room repairs have amounted to only a very few hundred dollars. There is a reduction of from 40 to 50 per cent in the personnel of the engine room, and there is an increase in the cargo-carrying capacity of about 6 per cent and the repairs are almost nil; that is, as far as the machinery and engines are concerned. And recently I had a careful examination made in the case of the WILLIAM PENN to see if the engines were wearing out and the metal becoming diseased, as metal does, etc., with the long strain and rapid changes in tremendous temperatures. So far, there is nothing of that sort.

Mr. Briggs: With what type of Diesel engine is this boat equipped ?

Admiral Benson: The Burmeister & Wain, sir. Of course, there are a number of others and just now, I might state in passing, there is a decided division of opinion in the technical world between the four-cycle and the two-cycle Diesel engine. I won't go into the technical part of that, but the present tendency is toward the two-cycle engine. We are collecting data from every ship we can get it, so that any buyer or any one contemplating buying and equipping a ship with these engines can come to the office and get all the information from us there is in regard to the different types.

The Burmeister & Wain is a four-cycle, and there is the McIntosh & Seymour four-cycle, which is similar to the Burmeister & Wain. Then, another one we have encouraged in selling several ships is one built by the Sun Shipbuilding Co., which is a Doxford, two-cycle, four-piston type, and I will say that has

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been worked out very successfully; there is the Busch Sulzer, that is a two-cycle engine. The Bethlehem Shipbuilding Co. is developing, and I understand from their last experiments, quite successfully, a type of their own that is a two-cycle engine. Then, there is the Werkspoor, that is being installed in several vessels by the New York Shipbuilding Co. In addition to those actively being developed in the United States, there is one called the North British type that gives great promise in a way, but I, for one, do not know enough about that to discuss it. I do know that it has been apparently pretty successful.

Mr. Briggs: Are these patent rights under some exclusive control, or are they rather generally distributed ?

Admiral Benson: I understand, for instance, the Cramps have the Burmeister & Wain; the Sun has the Doxford. Of course, McIntosh & Seymour have their own type, and the New York Shipbuilding Co. has the Werkspoor.

Mr. Briggs: While they call these Diesel engines, that is really a name applied to a certain type of engine and not as indicating the control of all the patent rights by Diesel ?

Admiral Benson: The general expression for it that covers all types would be "internal-combustion engines." They have given it the name of Diesel because that is the name of the man who got the idea up to begin with and they simply applied it to the same type of engines as they were developed.

In the case of the Shipping Board and the ships that are now completed, they were designed, as a rule, for certain speeds and to try to drive a ship at a speed higher than she was designed for very quickly reaches to the point where it is not wise to continue it; that is to say, the cost becomes too great. You can not drive a ship that is too poorly designed with economy. So that, in the case of the Shipping Board, to try and meet this situation, which we have anticipated for some time would eventually be accomplished, we have had a very careful survey of the whole fleet made, the conditions of the engines and all phases of the ships, the boilers, auxiliaries and, in addition, the design and the lines of the ships, to see whether the speed could be increased and, also, whether it would be economy to put internal combustion engines in the ships instead of trying to repair them by putting in new boilers and repairing the engines. We have a complete list of every ship in the fleet and we have segregated them into groups and types of ships that we feel are best suited for putting the internal-combustion engines in; in other words, ships that it would be prohibitive, practically, to put the old type of engine in and yet are good hulls for putting the internal-combustion engine in. Now, we have all of that data and we find that, in a good many of these ships, we could put Diesel engines in them and get sufficient horsepower to increase the speed to possibly not over 12 knots, and in a great many cases we would not be able to get that speed.

Mr. Davis: In that connection, what would be the relative cost of operation of a vessel that would develop 12 knots, as compared to one that would develop 10 knots, say both equipped with Diesel engines ?

Admiral Benson: It would cost more; but the increased cost, in that case, would not compare at all with the increased cost if the same purpose were attempted with a steam-driven ship.

Mr. Davis: I understand; but I just want to get a general idea as to the percentage of increase in cost for the two knots increase in speed?

Admiral Benson: I could not answer that. Mr. Conti, could you give him any idea on that? Mr. Conti is the marine engineer connected with the Shipping Board.

Mr. Conti: It will vary materially with the type of vessels.

Mr. Conti: I will try to answer that question as simply as I can possibly do it. Take, for instance, a vessel of about eight or nine thousand tons and, assuming that the lines of the vessel, to begin with, are such as to permit a speed of 12 knots without going out of the economical range of proportion, then in changing the speed from 10 to 12 knots the propulsive power will vary approximately as the cube of the speed. That is, if at 10 knots 2,000 horsepower is required, at 12 knots the power would be approximately 80 per cent greater and it would take 3,500 or 3,600 shaft horsepower to drive that vessel at 12 knots.

Now, the consumption of fuel will vary directly as the power; that is, if to drive the vessel at 10 knots takes 2,000 horsepower and she consumes, say, 9 to 10 tons a day, in order to develop another 2 knots, requiring 3,500 or will be exactly in the same proportion; that is, 3,600 shaft horsepower, the fuel consumed from 16 to 17 tons per day.

Now, as to the extra cost, there are certain fixed items in converting an existing vessel from a steamer into a motorship; there are certain fixed items such as deck auxiliaries; that is, winches, capstans, and windlasses and other items which would be substantially the same whether the power is 2,000 or 3,600. So that really the difference in cost between thee two powers will be approximately $150,000, possibly a little more — say $180,000 — when you take into account all of the various items that would be affected by the increased power. Of course, in the case of a motor-propelled ship the capital cost would be increased and the interest on the extra initial cost must be reckoned with in determining the cost of operation. So I dare say that 80 per cent, maybe, in fuel and possibly a little more in engine room personnel, it would cost about twice as much, in so far as the engine department is concerned, to run a 12-knot vessel as to run a 10-knot vessel.

Mr. Davis: Assuming we have a vessel of 8,000 gross tons and it is susceptible of conversion to the Diesel type installation that would develop either a 10-knot or a 12-knot speed. To begin with, in general terms and without analyzing the reasons, what would be the relative cost of installation between one for 12 knots and one for 10 knots, taking everything into account ?

Mr. Conti: I prepared a table showing the cost of converting a certain number of vessels of the type which, after careful study, we feel are the best suited for the purpose, and, just to illustrate, take the case of a vessel of about 8,400 tons dead weight, of which we have 20, and they happen to have a sufficiently large engine room, a sufficiently large shafting, to permit the installation of practically all of the power that the vessel can use economically. That vessel could be propelled to an approximate 12-knot speed, and I estimate that the total cost of that installation would be approximately $485,000 — $480,000 in round figures, say. That contemplates installing engines of approximately 3,400 shaft horsepower at 100 revolutions per minute. It works out $58 a dead-weight ton. Now, this same vessel, if propelled at 11 knots — I will give you three different speeds — the installation would cost $430,000, approximately. That is a difference of 1 knot in speed. The power would decrease from 3,400 to 2,700, approximately.

Mr. Briggs: Just give the difference in cost.

Mr. Conti: The cost will be reduced from $58 a ton to $46 a ton. If, again, the same vessel is equipped with machinery to propel her at a 10-knot speed, it will take approximately 2,100 shaft horsepower, or a little more. The cost would be around $370,000, or approximately around $40 per dead-weight ton.

Mr. Davis: All of your studies have been made upon the basis of the cost per dead-weight ton ?

Mr. Conti: Yes. But they are really a little misleading, because you can take two vessels of approximately the same size and the nature of the installations can be varied so as to bring about considerable difference in the dead-weight tonnage, and yet the dimensions will be practically the same and the power will be practically the same. It is really the total cost of installation which should be considered.

Mr. Davis: In that connection, I want to know whether the studies made under the authorization of the Shipping Board have led you gentlemen to reach a conclusion as to which speed vessels would be most economical to run in actual operation ?

Admiral Benson: That would depend a good deal on the service and on the routes they were operating on, sir.

Mr. Davis: In other words, if the authorization embodied in this resolution should be given the Shipping Board, it would be your purpose to convert those different vessels to —

Admiral Benson: To the particular service to which they are best adapted.

Mr. Davis: Speaking of the WILLIAM PENN, at what speed has the WILLIAM PENN operated in actual service ?

Admiral Benson: Eleven and a half knots. She has run about 110,000 miles and she has averaged practically 11½ knots.

Mr. Davis: Do you think that the state of this art is sufficiently developed that the Government would be justified in going into it on a wholesale scale at this particular time ?

Admiral Benson: Up to a certain extent, yes; because my idea would be that we would not undertake, say, more than 50 ships at the present time, and I think we would not only be well warranted in that, but I think we would be very, very reprehensible, if I may use the word, if we did not; because we would certainly be left behind. The steam engine is a thing of the past in commercial operation. My idea is that the cost would vary from $40 to $60 a dead-weight ton, to put internal-combustion engines in. I believe for similar ships to ours it would vary between $60 and $80 abroad. So with our ships and with the idea we hope to carry out, we would be able to give our people a decided advantage in the capital cost of their motorships.

Mr. Davis: In view of the fact the WILLIAM PENN has been the one ship above all others equipped with this internal-combustion engine that the Shipping Board has experimented with, and apparently with some considerable degree of success, what is the purpose in the Shipping Board proposing to sell the WILLIAM PENN at public auction, without retaining her for further experimentation ?

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Admiral Benson: Well, sir, we had a special reason for advertising her for sale and the Shipping Board, naturally, would not sell the *William Penn* unless under very peculiar circumstances; but we did want to feel out the market. I do not think the Shipping Board has any idea of selling her unless a condition can be shown by the prospective purchaser that he can do something with her that the Shipping Board could not do.

Mr. Davis: You wanted to ascertain the public demand and the viewpoint of the shipbuilding industry generally in regard to this type of vessel?

Admiral Benson: Yes. I do not want to mislead you; it was with no idea of deceiving anybody, or anything of that kind. We had certain restrictions on her sale.

[One bid received for the WILLIAM PENN was for $606,000 or $50 per dw. ton.—*Editor.*]

Mr. Davis: And you would not sell her unless you received a fair bid that would comport with the value of the vessel?

Admiral Benson: Yes. Another thing, we are not experimenting with the *William Penn* any longer; she is no longer an experiment. For instance, Mr. Pew sent out a ship not long ago from his yard with a Doxford engine, as I recall it, and he shoved her right off the dock and she went around to the west coast and they never had any trouble with her at all. But I want to emphasize another phase, that we should be in a position to help private owners and shipbuilders, and particularly anxious to help those people, so that we can loan them the money so that they can get it at a reasonable rate of interest and get it without any difficulty, in order to put the internal-combustion machinery and equipment in their ships. And one thing that I had in mind was that if the board could be authorized to equip a certain number of these ships, say 50, and we could divide them up with 10, or with 5 different shipyards, it would give an impetus and help the Shipping Board, which is sadly needed. Not only that, but it would help mechanics and designers in those five different establishments throughout the country to meet the situation that is unmistakable — that we have to come to the internal-combustion engine.

Mr. Briggs: To what extent have you had applications for the use of any of this loan fund from private interests for the construction of vessels equipped with Diesel type engines?

Admiral Benson: We have only loaned so far, I think it is, $400,000 in that direction; but we have had a good many applications and, in some cases — for instance, there is one pending now that will take, I think, a couple of millions probably. We have had a great many applications or inquiries to know if the same fund could be utilized for installing internal-explosive engines.

Mr. Briggs: I understand that recently the shipbuilders in Great Britain have had contracts for the construction of two vessels, one of 20,000 tons, to be equipped with the internal-combustion engine, and another one, recently, for 30,000 tons, and there has been some form of Government loan in connection with that construction or the installation of the Diesel type engine?

Mr. Briggs: You advocated here this morning, or suggested certain types of vessels which the Shipping Board now possesses could be disposed of at, say, $5 a ton, with the agreement they should be equipped with Diesel engines or internal-combustion engines of a character meeting with the approval of the board? Have you had any applications for the vessels, or any of the vessels, upon any such basis, or do you think they could be sold upon such a basis, and, if so, what are the reasons for such conclusions?

Admiral Benson: We have sold about 13 for that purpose; but if we could not only sell them the ships but lend them the money for installing these engines I think that would give a decided impetus to it.

Mr. Lazaro: Would the number of ships to be converted be based largely upon the demand?

Admiral Benson: No; my idea is not that. For instance, if any private ship owner goes to any of these builders now and wants to install an engine, whether Burmeister & Wain or Doxford or McIntosh & Seymour, or whatever it is, they must necessarily charge them a good, large sum of money for putting it in there; but if we can go to any of these companies and say we want you to convert 10 of these ships, why they ought to at least make a lower price. We have had a number of conferences, and they have all shown a desire and intention to try to develop this thing. They realize its importance and it is bound to come, and they want to get into the game as soon as they can, and they are frank to say by increased multiple production we can get decreased capital cost.

Mr. Briggs: As I understand it, the purpose of the board, if the authority is granted that is proposed in this resolution, or substantially that, would be to proceed with the conversion of these vessels up to a certain number, 50 or less, whatever the number might be, and then offer them to buyers upon the terms indicated by the proviso?

Admiral Benson: Yes, sir. If the board was granted this authority, it would naturally get all the information and talent it could possibly gather to determine what types would be best to put into these ships. We would not just go and put all and any type in; but we would give it, as we are doing, the most careful consideration. For instance, the board sent Mr. Conti abroad, a year ago last summer, at my request, to visit every yard in Europe, practically, where they were working on these engines, and we have about as complete data as there is available, and we have studied that very carefully. My idea would be not only to get the ships afloat equipped with these engines, but to develop the mechanical art amongst our people.

Mr. Briggs: I think you are absolutely right about developing that and maintaining and helping them.

Mr. McKeown: Admiral, would it not be better to go ahead, as you say, and equip these vessels with Diesel engines and then sell them to private purchasers, rather than to sell the tonnage with an agreement to convert them later?

Admiral Benson: On general principles it might be better in a way, but my interpretation of the function of the Shipping Board is that it is an instrumentality for helping the shipping world and not the board.

Mr. McKeown: By letting the contracts, as you say, in blocks of 10 vessels to one concern and 10 to another concern you are able to give the Diesel-installed boat at a much lower capitalization than he could convert one vessel himself?

Admiral Benson: I think he could. But at the same time I would not be willing to recommend a policy that would keep him from exercising his own wishes in the matter if he wanted to.

Mr. McKeown: What would be the difference in the loss? Would there be any difference in the loss to the Government by selling the vessel unequipped and selling it equipped with Diesel engines?

Admiral Benson: For instance, say we had a ship we would sell for $7.50 or $8 a ton for conversion, and we found we could get that ship, by having a number of them converted at once, for, say, $45 a dead-weight ton, making $53 a dead-weight ton for the ship. My idea would be to let the purchaser have it at that. You might add on a dollar or two per dead-weight ton to cover overhead expenses for having it constructed; but my idea would be the prices we are asking for ships now would be added to the actual cost of installing the plant; even though we gave a builder a contract to install 10 or 15 or 20 we would simply add the price we would have sold him that hull for in the beginning, plus the cost of installation, and let him have it already in order. My idea in doing that would be to give the American operator the handicap of a less capital cost in his operation over the foreign competitor.

Mr. McKeown: We expect to come to Diesel engines even if the Government operates the boats.

Mr. White: Section 11 of the 1920 act, as I understand it, creates this construction loan fund and authorizes its use by the Shipping Board in the construction of vessels of the most economical and efficient type? It also authorizes you to use that fund in aiding private owners to build vessels of that same general type, in private yards. Has it been the construction of the Shipping Board, or is it the construction of some other department of the Government, that that authority to construct does not include what I will term the lesser authority to alter or convert?

Admiral Benson: It has been gone into very thoroughly, and the opinions I think are unanimous which come to us that it does not; otherwise we would have been working under it. We feel that we have no authority to use that money to loan to private parties to convert or recondition.

Mr. White: Is that the judgment of the Shipping Board or of some other governmental agency?

Admiral Benson: It was the judgment of the Shipping Board and all of the legal authorities.

Mr. Davis: You stated, Admiral, that the board (I presume through your legal representatives) have given a very thorough study to the proper interpretation of the existing law on this subject. Of course, section 11 creates a loan fund of $25,000,000 a year for five years and then section 12 provides that all vessels may be reconditioned and kept in suitable repair and, until sold, shall be managed and operated by the board, or chartered or leased, and so forth. Now, is it the interpretation of the Shipping Board that that authorization in section 12 does not refer to the application of the loan fund, but would be dependent upon a separate appropriation by Congress?

Admiral Benson: Well, either that or from the revenues of the board. My own opinion, sir, is that we could use our moneys for converting certain ships we have to Diesel ships, without any further authority, just as we can repair them. For instance, if we have a ship

(*Continued on page 131*)

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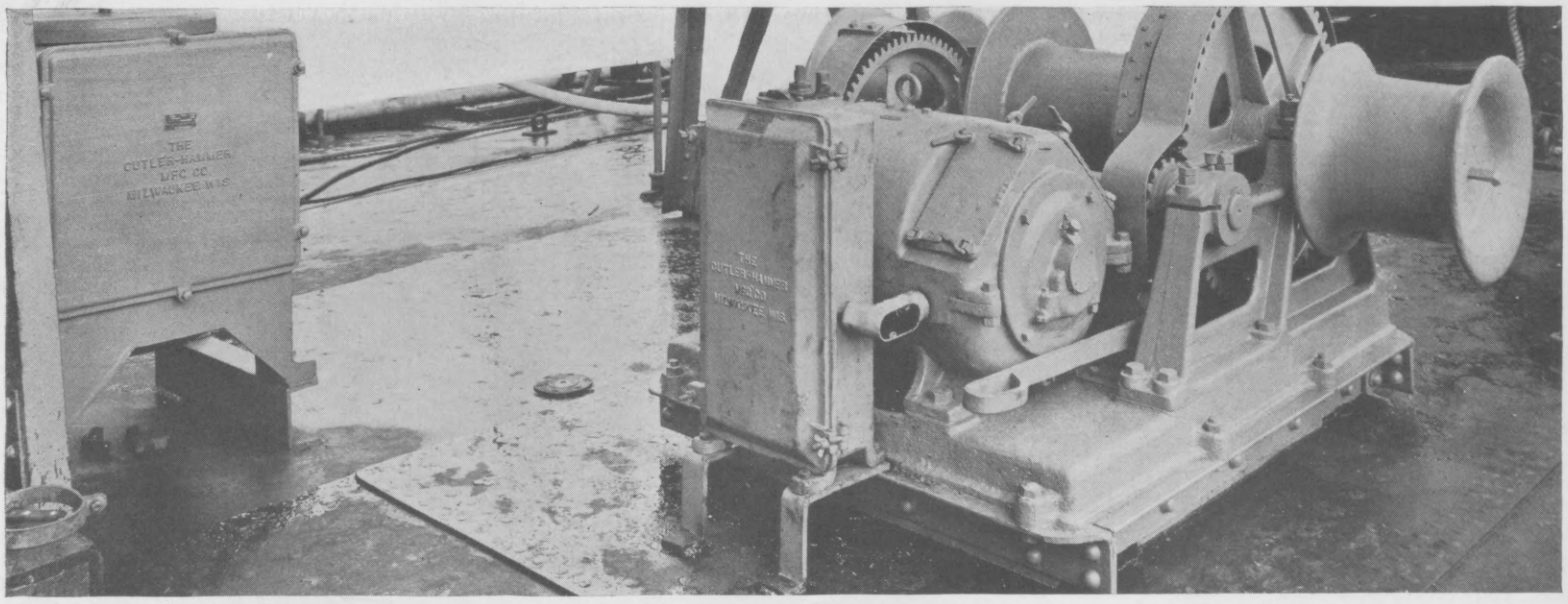


Hydro-electric windlass with G. E. motor, showing Cutler-Hammer controls on motor tanker "Solitaire."

Correct Design in Electric Deck-Auxiliaries

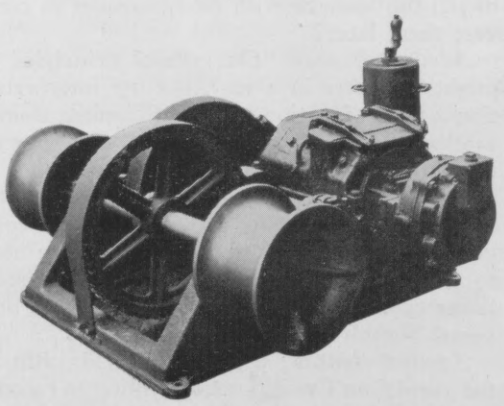
Probably the Most Comprehensive Treatise on This Important Subject Yet Published—Written Specially for **Motorship** *by G. E. Smith*

ONE thing that oil-engine power has accomplished is the bringing about of greatly increased use of electrical deck machinery, as it is only in comparatively isolated cases that steam is installed for this purpose on modern cargo motorships. Electrical deck equipment in conjunction with oil-engine drive has produced such great cargo-handling economies that the drop in port fuel-consumption is remarkable. Only three-quarters of a ton of oil per day is burned when working the cargo of a 10,000 tons motorship, compared with as much as ten to twenty tons for a steamer with steam deck machinery. While credit must be given to the Danes for first adopting electrical deck plant for motorships, greater development undoubtedly has been made in this country during the last few years. Although, it must be admitted that excellent progress has also been made in Great Britain and in Scandinavian countries.

A number of treatises have been written on electrically-operated deck auxiliaries, but they have been largely descriptive of certain particular examples and have not covered the principles involved. My endeavor is to show what is considered the very best practice as to types of machinery and electrical equipment. Winches, steering-gears, capstans and windlasses are today pretty well standardized as to duty and results, and these are the machines that will be discussed. Other deck-type machines have not as yet had sufficient service to make it advisable at this time to lay dow any general rules covering their characteristics. Before entering into discussion of this matter, however, let us for a moment consider some of the advantages and disadvantages of steam-operated deck machinery.

It is true that under ordinary circumstances a steam engine will operate until it falls apart; but, that operation is continually at lower and lower efficiency, and the drain on the boilers becomes greater and greater between succeeding overhaul periods. In order to maintain a torque at all points of the stroke sufficient for starting and operating the auxiliaries it is essential that steam be used in the cylinders with practically no cut-off and therefore no saving by expansion. This is why steam is an uneconomical power medium for deck auxiliaries. Still further lowering this efficiency is the loss from steam condensation in the long pipes leading to the machines and returning to the condensers, especially where high back pressure exists.

During the winter months steam must be kept on the line, or at least allowed to leak through sufficiently, to keep all parts free of water. This prevents freeze-ups and keeps the joints and other parts of the line in good condition pending the arrival of the vessel in port. The pipes leading aft are bled by the steerer, but steam, except for heating the crew's quarters, is not needed in those lines which lead forward—hence these latter pipes must either be carefully drained or kept warm by permitting a small quantity of steam to pass at all times. Owing to the straining of the ship and other causes, the pipes need constant watching to see that leaks are promptly stopped—otherwise there may be a resulting damage to the cargo or rotting-out of some of the wooden parts of the vessel in their vicinity.



Electric winch for motorships by Maine Electric Company.

A steam engine requires more attention to keep it in good condition, or at least it generally receives more than does an electric motor. An electric motor, either on land or at sea, frequently gets just about the amount of attention received by the motor in the fan on our desks—that is, none at all. This is particularly true in connection with steering-gears—hence, reliability of manufacture is of paramount importance.

Steamship-builders and steamship-owners have made careful tests of the main propelling-machinery and the auxiliaries connected therewith, showing the exact economies realized. Unfortunately they have not felt that there was a sufficient commercial return to warrant an investigation as to the power consumed by the various deck units. For this reason only a general idea of the saving in cost of operation of electric motors as compared with steam-driven machines can be obtained. Such records as are available, however, show that the saving is so great that I feel secure in claiming that the cost of ship operation is materially reduced by the use of electric deck-auxiliaries, whether the vessel be equipped with reciprocating engines, turbines, Diesels, or is electrically propelled.

Electrical equipment for sea service should be procured from firms having had considerable marine experience. During the last six years there has been a decided advance in the dependability of electric motors and controllers built

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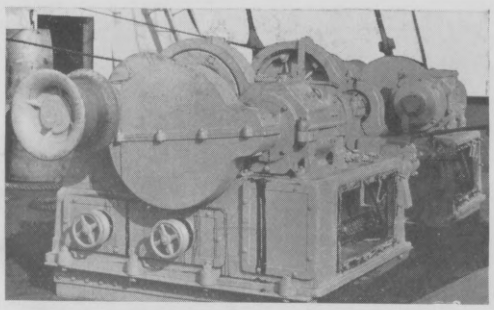
for this service. The marine department of electric companies has become most important and entirely distinct from all other parts of the organization. A motor or controller built for land service will in most cases be a complete failure when applied at sea. Conditions of atmosphere and location and the strains set up under ship conditions are absolutely different from any that are met in land work. After three days' service at sea, a land motor of the best type would probably be ready for the scrap heap. It is not that the requirements are more difficult to meet, that the engineering is of any deeper nature or requires more thought, but it is all entirely different. This is the point that ship-owners, ship-machinery builders and electric companies must realize,—*not better engineering — but different.*

Practical marine experience teaches us that usually a compound-wound motor is best for all of the deck auxiliaries. The amount of compounding must be carefully chosen to suit the conditions of the service. A series wound motor has certain attributes which are of particular advantage in starting a machine under load, in getting a greater speed at light loads and in slowing down to take the heavy loads. It is most desirable to handle light loads quickly,—it is even more desirable that heavy loads should be handled at comparatively slow speeds. For this reason electrical engineers not familiar with the requirements of marine service usually insist that a series-wound motor is the only proper one for this work. It is a very difficult matter at

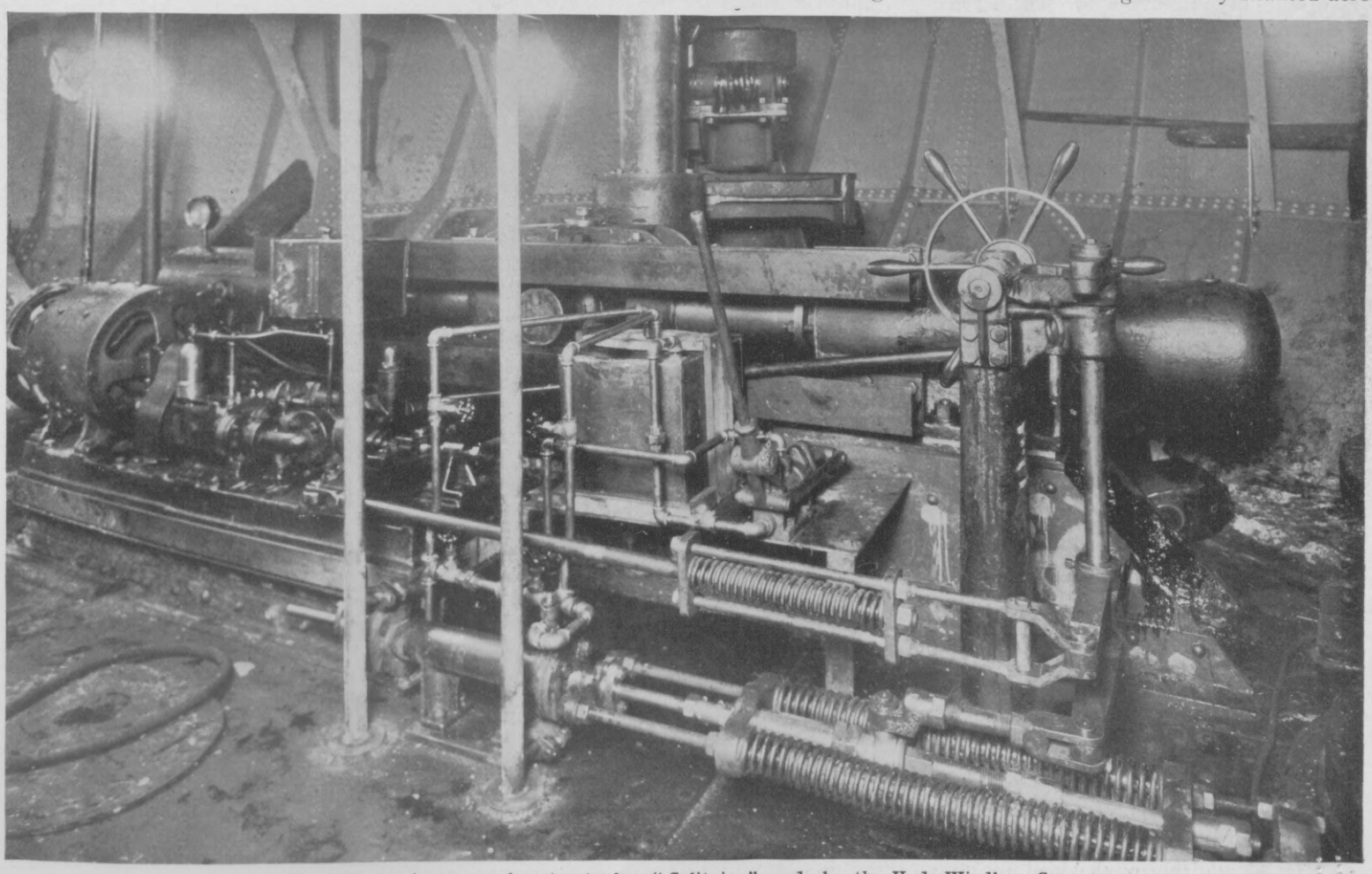


Cunningham electric winch with G. E. motors on the motorship "Kennecott."

times to convince them that they are wrong. The actual power required to operate some deck auxiliaries under no load is so small that the speed of the armature becomes excessive. This is dangerous, not only for the motor itself, but for the machine it is operating and for the structure of the ship on which it rests. For this reason a compound-wound motor is indicated in the majority of cases. In order to gain certain advantages in operation and control it is sometimes possible to use a slow-speed motor, series wound, which will not go to a dangerous overspeed at low loads. There is usually a loss of efficiency which must be considered. It is also good practice to have the armature of small diameter, preventing the fly-wheel effect resulting from the inertia of one of large diameter. This is especially noticeable in connection with efficient functioning of the electric brakes.

The brakes are a most important part of equipments requiring them. There are two types, the disc and the shoe-brake. The disc has two advantages over the shoe-brake. First, it is self-contained so that no damage can come to it from outside sources. Secondly, it takes up less deck space. On the other hand it has certain disadvantages which apply especially to the larger sizes. Its heat is less easily dissipated, adjustment is more difficult and it is more expensive to build. Because of these drawbacks to the disc type the shoe-brake is considered standard by the electrical manufacturers and is the type in most common use to-day. In addition to the careful thought necessary to determine the proper brake for an equipment a feature of even greater importance is the type of control.

The control must be as simple as it is possible to make it and when practical all but the actual operating end of it should be placed below deck where it will receive ample ventilation and will not have to be made of watertight design. In general watertight equipment is less efficient and more costly than the open type. The ship-owners, even more than the ship-builders, frequently find most important reasons why the resistance and control units should not be located below the deck. They claim below-deck stowage interferes with their cargo, crew's quarters and stores. Considerable argument is needed to show the advantage of under-deck stowage of electrical equipment in preference to cargo. As a usual thing the ship-owner cannot be convinced, as it apparently means so much cubic space taken out of his cargo-earning capacity. Contactors are of considerable advantage in that they automatically prevent a motor being suddenly shunted across



Electric steering gear of motor tanker "Solitaire," made by the Hyde Windlass Co.

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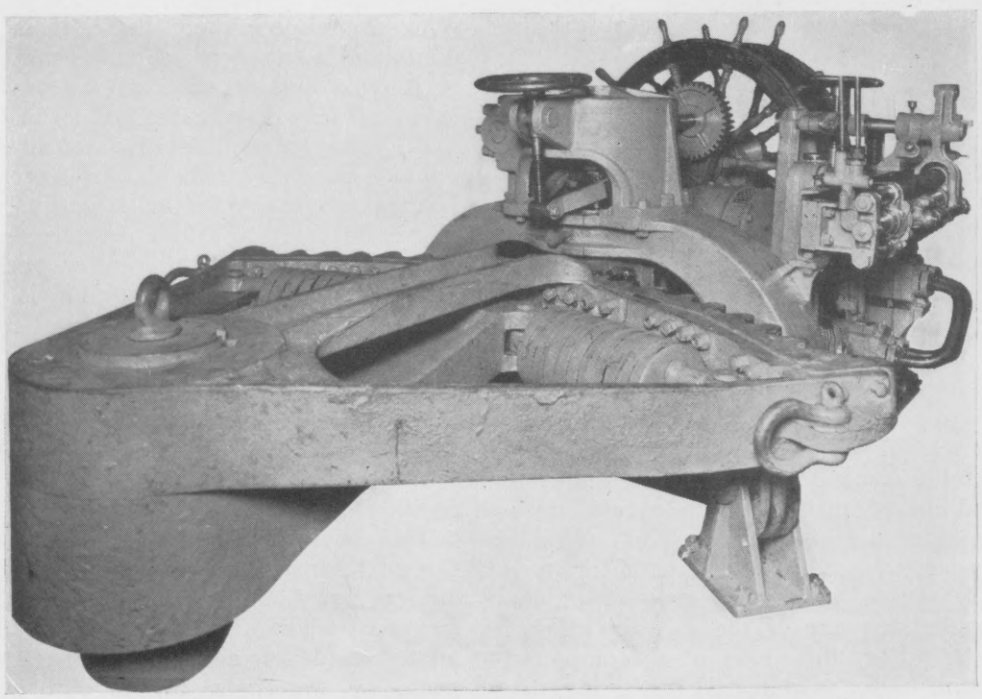


Steering gear made for motorship work by Allan Cunningham, Seattle, Wash.

the line and require that it shall come up to speed gradually. Where used they must be of very rugged construction and the resistance and fingers designed with care to reduce sparking to a minimum.

Not only must the electric motors and control be built by those understanding the work, but the requirements for the mechanical end also are much different from those in land service. Here, too, successfully operating machines can only be built by those having had years of experience in their manufacture; who have followed along the growth of the peculiar practical engineering necessary to give the machines the infallibility needed for sea service. Miles from home a machine must always do its work, repairs cannot quickly and readily be made and should not be necessary. Delay due to the non-use of a machine costs more money than the repairs to that machine. So, for the mechanical end we repeat what was stated in an earlier paragraph regarding the electrical requirements,— *not better engineering — but different.*

Let us now consider the machines individually. First, and most important from the earning point of view, is possibly the hoist or winch. This machine operates only in port, but frequently from one o'clock noon until twelve o'clock noon the next day (twenty-three hours) it runs without stopping. Its only best period is the noon lunch hour. Moreover, the machine has been subjected to the washing of the sea, the heat of the sun, ice and storm possibly until the ship's arrival in port. There is little time then to go over the machine and be sure it is in proper order, to lubricate it well and have it working 100 per cent when the ship ties up at the dock. A specification for a perfect marine cargo winch might in outline be as follows:

First — minimum deck space with maximum efficiency.

Second — all gears and machined parts protected from the weather, gears running in oil and means provided for easy access to all moving parts.

Third — perfect lubrication and quiet operation.

Fourth — moving parts designed and protected so that the rope cannot catch in any portion of the machine.

Fifth — the whole machine rugged and strongly attached to heavy foundations. These machines must withhand handling by all types of stevedores in the ports of the world.

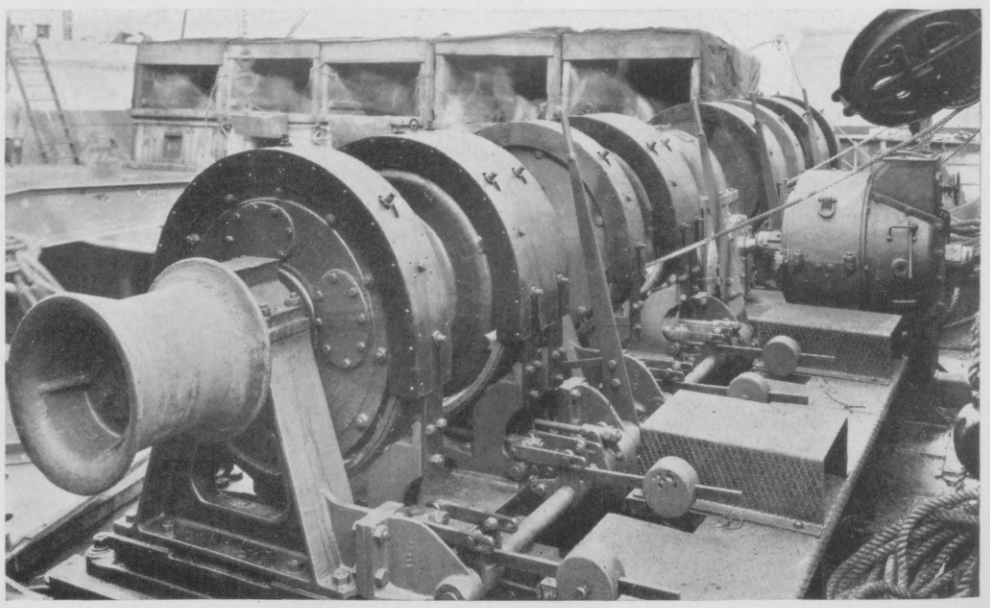
Sixth — dependable, rugged marine electric motors, controllers and resistance boxes designed to meet the particular kind of cargo that is to be handled by the ship for which the installation is made.

One of the best and probably the most widely known example of successful electric cargo-handling winches is the equipment installed on the American motorships WILLIAM PENN and CALIFORNIAN. These machines have been subjected to most arduous service, have handled cargo most expeditiously, and the repair bills after their various voyages *have been in cents, not dollars.* Mr. Pierce, electrical engineer for the Cramp Company, recently stated that these winches were able to handle cargo faster than the dock fcailities could bring it within their radius. In the case of the WILLIAM PENN it required only 90 gallons (2¼ barrels) of oil per day of twenty-four hours to operate the auxiliary Diesel engines and their generators, furnishing current for the ten cargo winches, the minor auxiliaries operating in port and the electric lights. This represents in dollars and cents probably not over one-tenth of the amount required for similar steam auxiliaries.

These machines quite fully meet the specification noted above. The parts are rugged, their lubrication is automatic to a large degree, and the hoisting ropes cannot become entangled with the gears. These machines have two speeds arranged for a normal high-speed freight handling and for a low-speed heavy pull by the shifting of protected gears. These are shown clearly in one of the accompanying illustrations. The Westinghouse motors for these machines have a very small amount of compounding and have responded wonderfully well to the cargo-handling requirements. General Electric motors on similar winches for recently built ore carriers are all series wound, but the speed is low and shop tests have indicated that the running light speed will not be a dangerous one.

In general, however, the writer believes that a small amount of compounding and a little higher speed motor is of advantage from the point of original cost, maintenance and operation. The owners made the usual requirements that both resistance and control should be on the deck, there being no available space for either below deck. These have been very successful in service. The resistance is in a water-tight box ventilated during operation. Ventilation is by means of doors at the top and bottom and until these doors are opened no current can pass through the controller. This interlocking is a most important feature.

The winch ends are frequently needed in handling package freight cargo. Under



One of the largest electric winches ever built. It is of Pirrie-Scott design and is operated by a 50 h. p. motor. It forms part of the deck installation of the motorship "Lobus."

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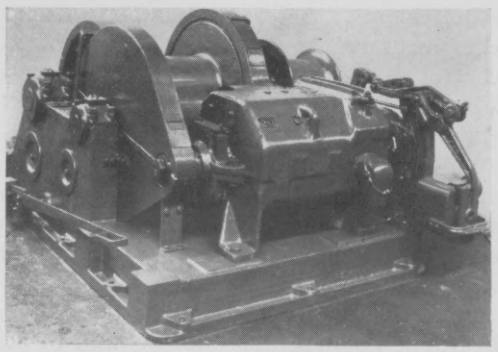
these conditions speed regulation by means of a controller is essential. This reduces the amount of rope slippage when hoisting and the resultant wear on both the rope and the ends. The use of a lever for the controller has proven to be better than a wheel. It is easier to handle and less tiring to the stevedore. In Europe, the preference is still for a wheel.

Deck enclosures in which the resistance and at times even the winches themselves can be stowed are well worth consideration by both the ship-builders and owners. These would make possible advantages in both electrical and mechanical design not obtainable when watertightness is of primary importance. It might be well to draw attention to the fact that one company has under consideration a ruling that they will not furnish watertight resistance, making it necessary to put this resistance either in proper deck-houses or to stow it below the weather deck.

A spur-gear design winch is standard in this country. Successful worm designs have been built here and abroad, the latter being very popular in Gt. Britain and on the continent, especially for passenger boats on account of silent operation. While more quiet they are not as efficient as spur-gear drives, and we in this country believe they are not as satisfactory for most services. Some foreign passenger ships are equipped with electro-hydraulic winches which are practically silent. These are very expensive and lower in efficiency. For winches having highly efficient worms the motors should be about the same as for the spur type, but for those having worms of low efficiency a series motor is needed. The control conditions remain the same under all circumstances. All spur-gear winches need dynamic braking on the lowering side in addition to the electric brakes on the motor. Mechanical brakes on winches are unnecessary. The stevedores or the ship personnel generally remove the brake-bands and gear if originally supplied with winches.

As many older ships are not properly equipped for cargo-handling it is essential that winches be provided on the dock. These must be well designed and as efficient as those for ship installation. The ports of New York, Philadelphia and Camden have all started to equip their docks and have purchased portable winches which can be moved from door to door and, by means of elevators, from deck to deck of the dock. These are designed along the same general lines as those indicated for the motorships. Direct current is usually supplied to the docks and this gives a very complete control of the motors. At the docks in Camden, N. J. alternating current only is available. In order to meet, with alternating current, the varying speed conditions required for the service, it was necessary to make extensive experiments and studies before completing the final design for the machines. These machines have been in most successful operation for some time.

About seven years ago an electric winch



American Engineering Co.'s cargo-winch on motorship "Californian," driven by a 30 h. p. Westinghouse d. c. motor, compound-wound, two mechanical speeds, dynamic-brake, solenoid shoe-type brake and manually operated brake. Controllers are arranged so one man can operate one or two inches. Can hoist 5,000 lbs. at 170 feet per min., or lower 5,000 lbs. at 470 feet per min. on fast gear. Will hoist 10,000 lbs. at 90 feet per min. on slow gear.

with distant control was supplied to one of the Philadelphia docks. This was an entirely new departure at the time and careful study was given to the subject by the mechanical and electrical companies furnishing the equipment. That machine has handled loads in excess of its designed capacity and has been in constant service during the seven years. In reply to a recent inquiry it was found that the cost of upkeep had been $1.42, or about twenty cents a year. Of course this is lower than the average upkeep, but we believe it fairly represents the reliability of properly designed electrically operated winches.

The next machine to be considered will be the steering-gear. Here again careful thought should be given to the character of the service before the type of gear is chosen. The saving by the use of motors over steam is probably greater with this gear than with any other on account of its

Cunningham electric capstan on the Philadelphian motor tug "Hustler."

constant operation. Properly designed steering-gears, whether steam or electrically operated, are absolutely reliable. It is inexcusable for a steering-gear built by an experienced firm to fail to meet the duties imposed upon it by service conditions. Let us examine the important needs of this machine.

First — it should have precision of movement.

Second — positive holding-power under unusual wave conditions.

Third — resiliency under sudden shock.

Fourth — absolute reliability.

Fifth — economy in operation.

There are two general types for electric motor application to steering-gears. The first is the use of a motor in place of a steam-engine for drum type, screw-gears, quadrant-gears and others. The other is the electro-hydraulic system where the motor is used to operate a variable stroke, reversible pump of the Hele-Shaw or Waterbury type. Hydraulic speed-gears have been used with fair success for the operation of some of the types of mechanical gear, both quadrant and drum, but there seems to be no particular advantage in adding this extra unit to the mechanical gear and the straight electro-hydraulic using the ram system is decidedly to be preferred. An electro-mechanical type is more economical than a steam gear in that it uses. power only when doing work. It is not as economical as a hydraulic-gear for the reason that it is constantly subject to a heavy starting torque. Occasionally the motor is started and stopped as often as five to ten times a minute. In its application it is necessary to use spur-gears, worms, or screws and nuts, and there is a loss due to the operation of these. The hydraulic-gear is more expensive as to original cost, but in its economy of operation its saving is such as to much more than pay for this difference in a comparatively short time.

The electro-hydraulic gear has positive holding power,— the liquid is practically incompressible, and the liquid must move in order that the rudder shall move. The screw or worm acts as the holding unit in gears of the electro-mechanical types. Spur gear units are dependent upon the brake at the motor. In all cases, the electric brake, either of the disc or shoe type, is needed to bring the armature to a quick stop. Where the holding power is dependent upon the brake it must be of large size, but where the worm and screw prevents the movement of the rudder then one simply sufficient to overcome the inertia of the armature is needed.

For steam-gears the rudder-holding power is usually the screw or worm and with spur-gears the compression of steam in the cylinders acts as the brake. To meet unusual rudder stresses the hydraulic-gear is supplied with a relief-valve which permits of an easement of the rams. The following gear returns the rudder to its previous position when the shock has passed. With the screw or worm gear the blow can only be taken on the thread unless

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some form of spring buffer is used. This is quite an advisable addition to an installation, but adds considerably to the cost of the equipment. This excess cost is not always found desirable by the ship-builder and the ship-owner.

With a complete spur-gear drive, whether steam or electric, the blow is carried back through the gears, either rotating the motor against its brake or the engine against steam compression in its cylinders. With the easement of the load the rudder is restored to its original position by the follow-up gear.

There are several very successful electric follow-up drum type installations on the new ferry-boats plying between Staten Island and New York. Shaft transmission is used between the pilot-house and steering-room with a controller at the motor and a follow-up from the drum shaft. This is effective if the leads are short, but where the leads are long the straining of the ship is apt to cause the shafts to pinch at the bearings. Wire rope transmission is quite satisfactory for long leads where mechanical control is preferred by the owner. The Hanscom drum-type with the spring take-up device is the most successful.

For worm-operated steering-gears of the drum or quadrant type an almost straight series motor is generally used, a small amount of shunt winding being essential to prevent possible racing and the resultant racking of the machine and its foundations. A 50 per cent shunt field has given good results for some of the worm gears. It prevents overspeeding of the motor, and dynamic braking is more effective than with a weak shunt field. The work for the solenoid brake is also less.

For the electro-hydraulic type a shunt motor is needed for the reason that pumps of the Hele-Shaw or Waterbury types must run at a constant speed. As the constant-running pumps place no starting load on the motors shunt-winding fully meets all requirements. A very simple starting equipment may be used, usually push-button control at the gear and in the pilot-house. The electro-hydraulic system practically fulfills the specification of the ideal steering gear. It requires very much less power and is practically no drain on the generator service. As the motor operates continuously there is no loss due to frequent starting torque.

For those not familiar with the electro-hydraulic equipment it may be well to add a few words of description. It consists of two or more hydraulic cylinders operating rams connected to the tiller. These cylinders may bear any relation to the tiller, but where possible the arrangement is such that the greatest amount of effective power is applied at the hardover positions of the rudder. This is accomplished by connecting the tiller directly to the rams so that increased leverage is obtained at increasing angles of the rudder.

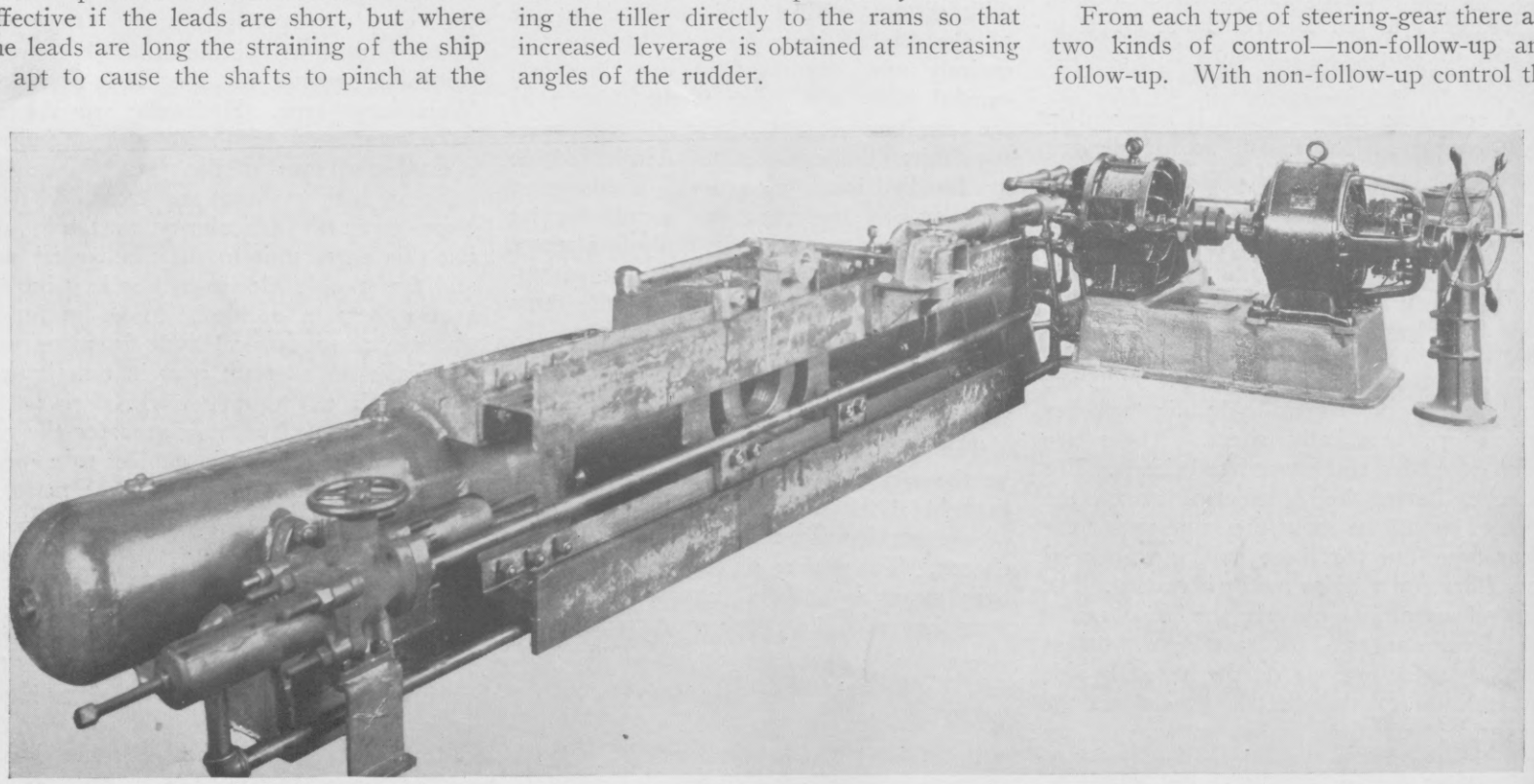
Precision of movement is obtained to a greater degree with the electro-hydraulic gear than with any other type of steering gear. The slightest movement of the pump control itself will give a corresponding movement of the rams operating the rudder. In addition to this, these rams being connected directly to the tiller, there is no lost motion. To quote the opinion of a ship-builder:

"Relative to the steering-gear, it is questionable if a more satisfactory type than the electro-hydraulic has been developed. The type is ideal for control and makes a minimum demand upon the generating plant with an efficiency equal to that of any other type. It should be seriously considered for new ships. The electric motor for steering-gears offers the greatest saving of any single auxiliary on the ship, and no doubt in many ships the steering-gear could be replaced by an electro-hydraulic unit with a considerable saving and without increasing the size of the generating sets."

For the scouts, battleships and airplane carriers, the cylinders of the hydraulic steering-gear are arranged fore and aft,—links and pull-rods connecting with the rudders. This does not give the advantage of increased power in the hardover positions. The control is from the pilot-house through pilot motors installed in the steering motor-room, which operate the local follow-up system handling the tilting-heads or control-rods of the pumps. The arrangement is very much more complicated than that used for the merchant service in order that it may meet the Naval requirements. The electric control panels are built so that when the current for the generator circuit fails, storage batteries instantly take up the load and carry it until the restoration of the current in the main loads.

From each type of steering-gear there are two kinds of control—non-follow-up and follow-up. With non-follow-up control the motor is operated through a master controller in the pilot-house, the quarter-master both starting and stopping the motor. This applies particularly to electro-mechanical equipments. In merchant-ship practice there is no pilot-house controller for the electro-hydraulic, as the pump stroke only is controlled from the pilot-house and it is necessary to have some form of mechanical follow-up at the gear to bring the same to neutral. In the follow-up system the controller is near the steering-motor, connected differentially to both the pilot house transmission and the steerer. The transmission may be of mechanical design or some form of electric or hydraulic telemotor. The steersman starts the gear in motion — the steerer stops it by transmitting its own movement to the follow-up controller.

Hydraulic telemotors are used almost exclusively abroad. For some reason they do not meet with the same favor among our ships' officers. This may be partly due to



Hydro-electric steering-gear installed on the m. s. "Seekonk" replacing the old steam gear. A double-acting 10" ram moves the tiller through a sliding nut, giving an increasing mechanical advantage as rudder approaches the hardover position. The ram is actuated by a Hele-Shaw pump driven by a Westinghouse constant-speed motor, control of the pump being by telemotor from the pilot-house and by trickwheel.

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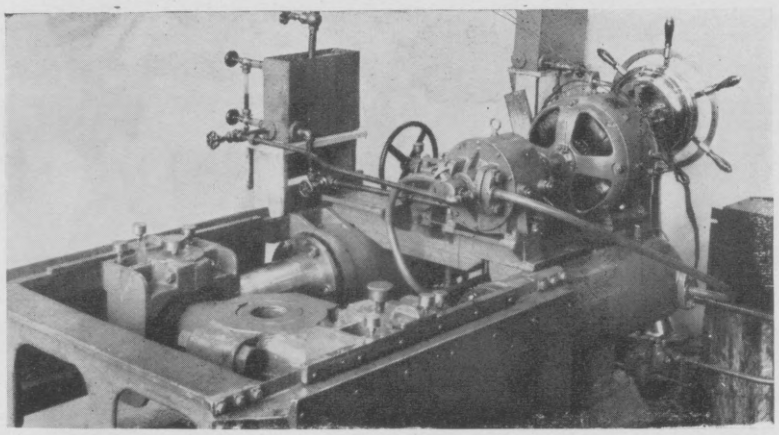
the fact that they are often not properly installed and officers frequently do not understand their care. A number of the electric telemotors are giving satisfactory service. The trouble from air in the line experienced in hydraulic telemotors is avoided by the use of electric telemotors.

If for any reason the steering-gear is carried away or becomes disabled, the captain is called upon to handle the spare tiller. An electrically-operated machine has the same advantages that the electric operation of other auxiliaries has shown. Where possible the motors should be placed below deck so that they can be of the open type and self-ventilating. This leaves the capstan-barrel free on the deck for the handling of ropes in every direction without interference from motors or gears. The ship-owner, however, is rather prone to insist that the motors shall be placed on the weather deck and leave free the space below. This means that the barrel must be somewhat higher from the deck and yet must not be too high for the convenient handling of the hawser by the men. The motors should be compounded in accordance with heavily compounded to prevent their running away with light loads and yet not reduce their maximum speed to a degree to prevent quick handling of the hawsers when taking in slack. Personally, I consider reversible motors for capstans unnecessary, inadvisable, and at times even dangerous. A number of rather bad accidents have occurred on shore installations due to this reversing feature.

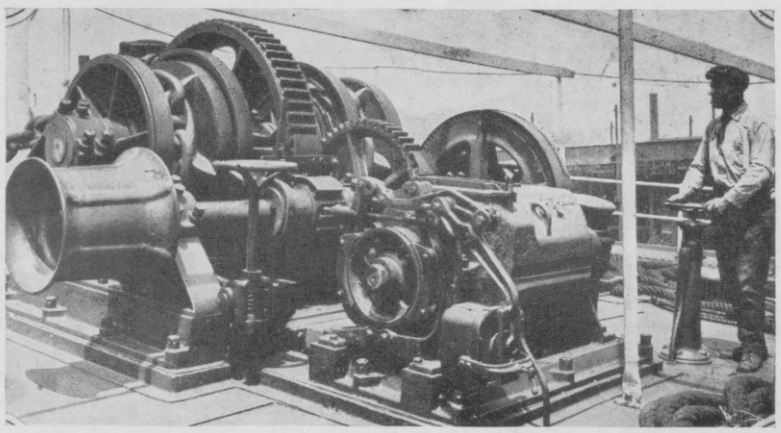
The last machine we will discuss is the windlass. For steam-operated anchor-windlasses the cylinders must be made sufficiently large to give the maximum pull required in breaking-out the anchor. This means that during the ordinary handling of the anchor, even though a very much smaller quantity of power is required, the steam must be chopped off (and I use the word advisedly) in pieces of the size of its maximum cylinder capacity. With an electrically-operated windlass only such power as the anchor calls for will in turn be called for from the generator. The motor will absorb only the amount of current necessary to handle the load of the anchor at that particular moment.

At times there may be reasons for lowering under power and to meet this condition it is advisable to have dynamic braking on the lowering side. With a windlass there is usually less than 180 degrees contact on the cat. In order that this contact may be effective it is essential that the chain be held firmly to its work. Four or five turns of the hawser are made around a capstan barrel, and the free end is taken off by one or more men holding it sufficiently taut to make the rope grip the barrel. This is impossible with a steam windlass, and the only way that the chain can be satisfactorily and firmly held is to have sufficient weight inboard to make the links grip the lugs. With machine-made chain and Kintner shackles it is quite possible to lower under power on a horizontal-shaft windlass, but with the standard shackle and hand-made chain, the links are very apt to jump unless permitted to run free, particularly when the locker is not located very low down in the ship.

A deep chain-locker is an important feature in the installation of a windlass. This seems to have been lost sight of in the



American Engineering Co.'s electro-hydraulic steering-gear on motor-yacht "Delphine," showing folded seven-inch plungers with Hele-Shaw pump, and 3 h.p. Reliance Elec. & Eng. Co. driving motor located on top of cylinders, torque capacity 675,000 lbs.



Motorship "Californian's" electric spur-gear windlass with 668 h.p. d.c. motor, compound-wound, dynamic braking, solenoid shoe-type brake, and manually operated brake of the pump type. Can lift two 7,400-lb. anchors simultaneously at 4½ fathoms per minute.

the design of the mechanical parts. For single-thread worm-gear capstans a series motor is usually best. With capstans having highly efficient worms some compounding is desirable. Just sufficient shunts should be used to prevent overspeeding. The slack of the ropes must be taken in as rapidly as possible, but the rope speed cannot exceed 150 to 170 feet a minute, for no matter how well trained, men cannot take rope off a capstan barrel at a greater speed than this.

The capstan requires only the simplest of electrical control. The motor operates continuously during the use of the capstan without speed regulation. For this reason a simple starting-switch or device is generally all that is necessary. Grid resistance and the controller should always be placed below deck where ample ventilation can be supplied. Where the apparatus is non-overhauling, a motor almost or entirely series may be used with very good results and this has some advantages over other types. Where a more efficient type of capstan design is used, as with spur gear, it is essential that these motors shall be quite

Another important advantage of an electrically-operated windlass is the fact that no matter what the weather and no matter how covered the windlass is with ice and snow, the quarterman can turn on his current, starting and stopping his motor a few times until the gears clear. Within a few minutes the windlass is operating in its normal manner. It is unnecessary to draw a picture of the work required to start a steam windlass under similar conditions. The use of axes to clear the ice from the reciprocating parts, and the gradual warming of the cylinders with steam to get them in operative condition require not less than thirty minutes of arduous labor. A motor properly built for anchor handling will readily handle three times its rated capacity momentarily. For this reason a much smaller motor can be used than would be required to constantly meet the maximum demand of this machine. Then, too, electric control is very much quicker and more positive than with a throttle.

When dropping the anchor the chain does not function well over the wildcat of a windlass unless it is allowed to run free. last few years and there has been a tendency to install the anchor gear right up in the nose of the ship with a short and sharp lead through the hawse pipe, and with the chain stowed just below the windlass deck. Thus a very large amount of weight is overboard and pulling on one side of the cat, whereas on the inboard side there is a very small amount of weight hanging down into the locker to keep the chain functioning properly. In case of fouling, or while braking out, the chain is very apt to slip and jump the lugs, which is hard on the machine, on the foundations, and particularly hard on the officer who is endeavoring to stow his anchor and cable rapidly.

The modern windlass being an all spur-gear machine is highly efficient and as the chain load can be disconnected from the machine it is quite possible for the motor to run away with the load unless a controlling compound winding is used. As the windlass is needed only occasionally high efficiency of operation is not a valuable asset. This being true it is possible that an arrangement whereby a series motor is

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Once more the U. S. War Department leads the way. The Engineers' Office new Diesel-electric stern wheeler "J. B. Battle" powered with Winton-Westinghouse Diesel-electric drive.

Diesel-Electric Stern Wheel Tow-Boat

J. B. Battle, a 119-ft. Shallow-Draft Vessel for the U. S. Engineer's Office of the War Department Runs Trials—Equipped with Winton-Westinghouse Installation

ABOUT a year ago bids were called by the U. S. Engineers' Office of the War Department on a Diesel-electric towboat of the stern-wheel shallow-draft type for service at Mobile. The contract for the hull was awarded to the Charles Ward Engineering Works, Charleston, W. Va., while the Diesel-electric machinery went to the Winton Engine Works and the Westinghouse Electric & Manufacturing Company. This interesting vessel recently ran trials. The successful results will provide information to operators of river boats in this country as to the economies and benefits to be derived by the adoption of this system for vessels of similar size, and specially of larger dimensions and powers.

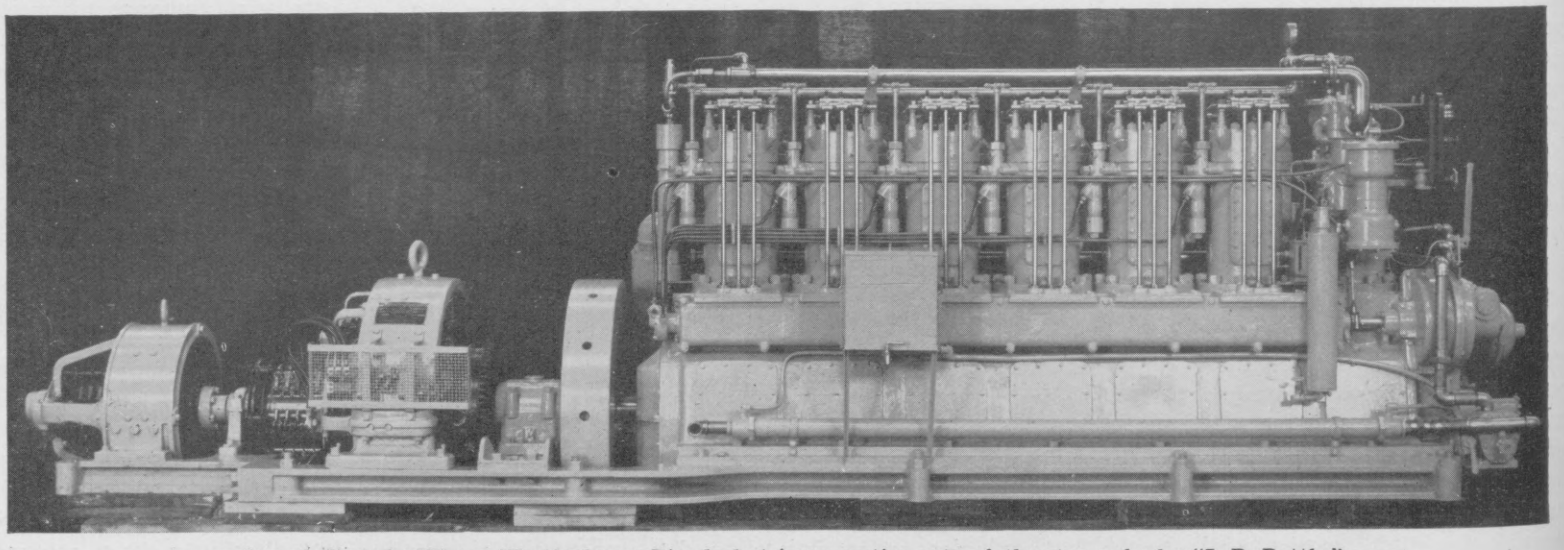
J. B. BATTLE is the name of this unique craft, which was designed in the office of the Chief of Engineers at Washington, D. C. The boat is constructed entirely of steel, with the following dimensions:

Length o. a	119′ 4″
Breadth md	23′
Depth	5′
Draft, loaded	3′ 6″
Power, propelling motor	200 s. h. n.
Power of two main engines	150 b. h. p. each

Located in the forward end of the deck-house are two 150 h.p. four-cycle type Winton Diesel engines, each driving a Westinghouse 90 k.w. 125 volt, 450 r.p.m. main generator, and a 10 k.w., 125 volt, direct-connected exciter. The two generating-sets are placed abreast of each other, and are mounted low in the hull, in order to make the center of gravity of the machinery parts very low.

In the aftermost room of the deck-house is mounted the 200 h.p., 240 volt, 600 r.p.m., Westinghouse propelling motor which is flexibly coupled to a Fawcus double-reduction gear with a speed reduction ratio of 23 to 1. The gear drives a lay shaft which extends through both sides of the deck-house and which carries cranks placed at a 90° angle with each other. The two cranks are connected by parallel rods to similar cranks on the paddlewheel shaft, thus transmitting the motion of the lay shaft to the wheel shaft. The stern-wheel is 15 feet in diameter and 15 feet long, and has 13 buckets 30 inches deep.

The main switchboard is located in the forward end of the engine-room, and carries the control equipment for the propulsion machinery as well as for the 7-½ kw. Winton gasoline-engine driven auxiliary generating-set, and various feeders for other auxiliaries and lights. The wheel-house is located immediately above this point, and adjacent to the steering wheel there is located a control pedestal as shown in the accompanying photograph, by means of which the operator may completely control the propelling motor. The small panel on the top of the pedestal carries instruments which indicate the generator voltage, the propelling-motor field current, the propelling-



One of the twin Winton-Westinghouse Diesel electric generating sets of the stern wheeler "J. B. Battle."

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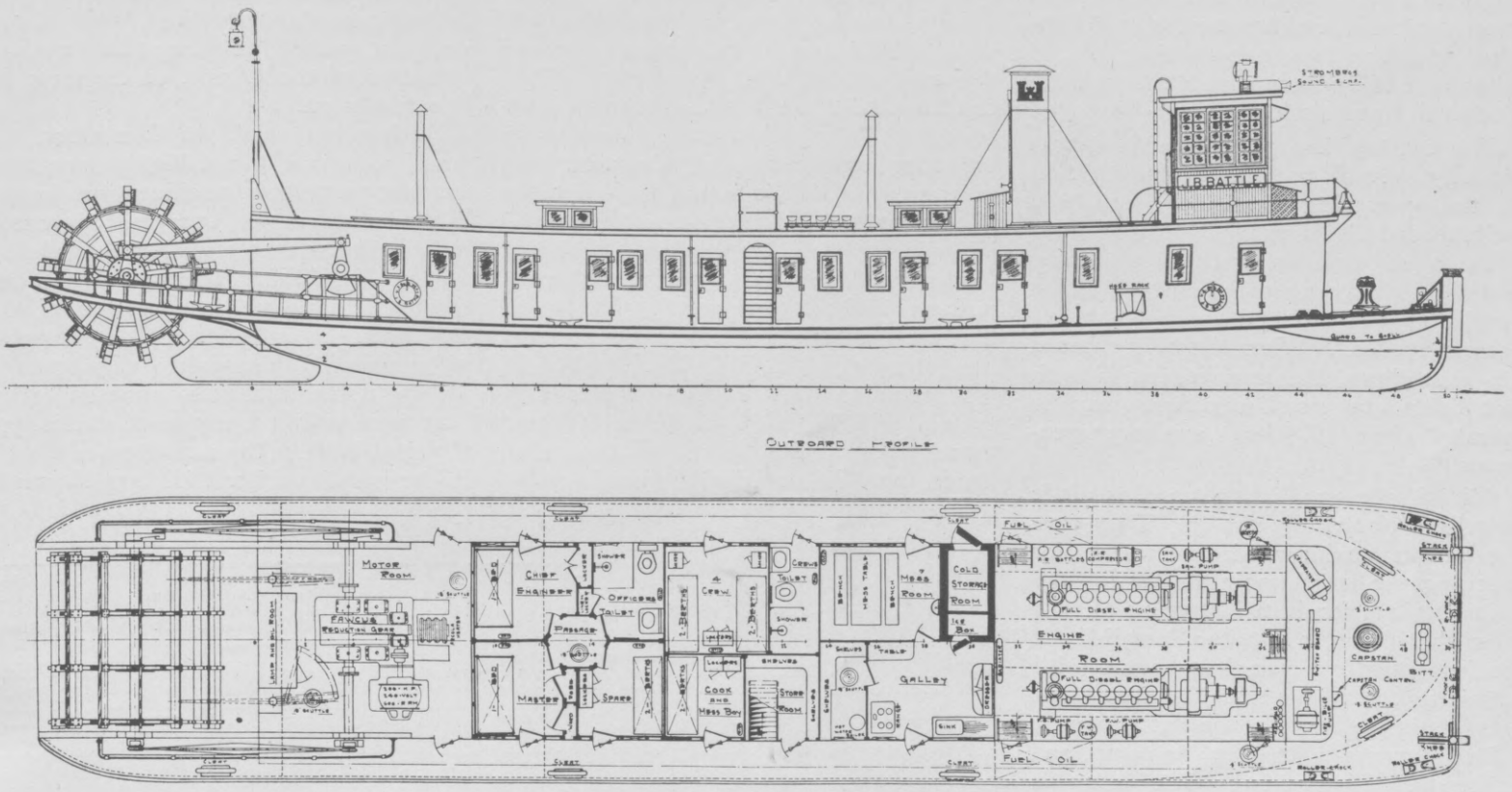


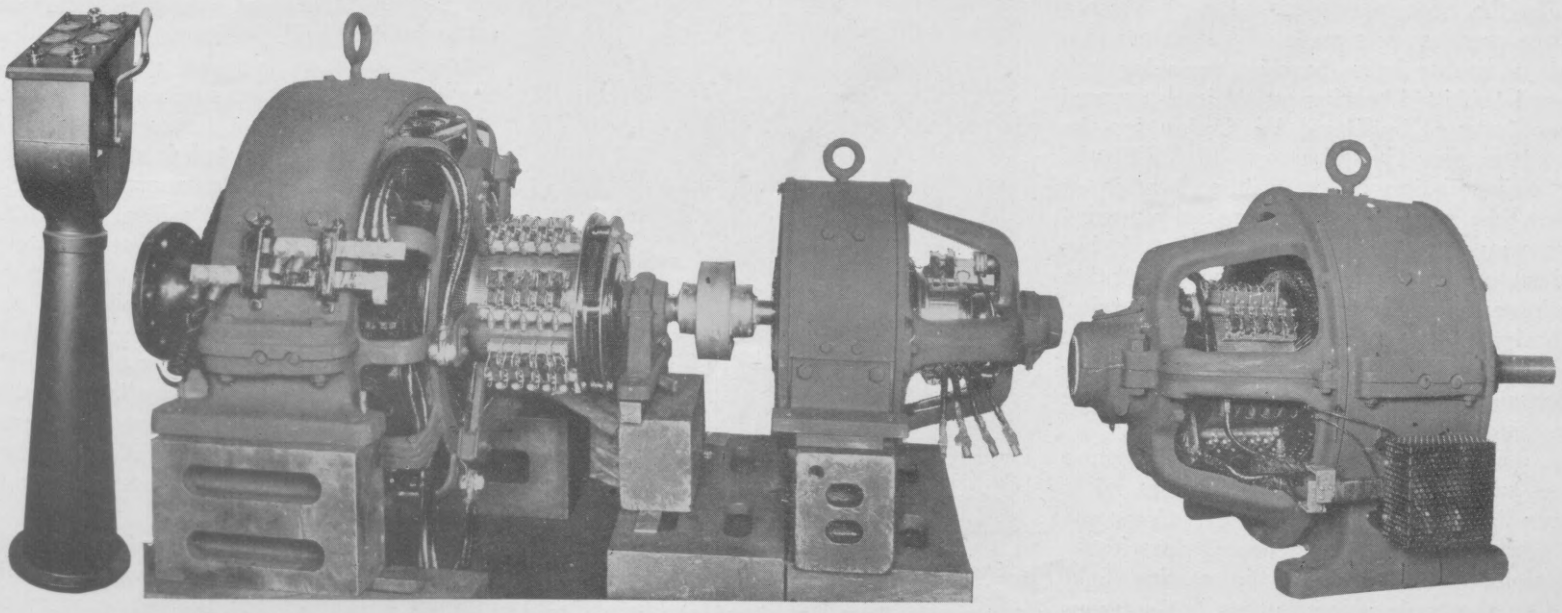
Profile and deck plan of U. S. War Department's stern wheel tow-boat "J. B. Battle" propelled by Winton-Westinghouse Diesel-electric drive.

motor line current, and the speed of the paddle-wheel. The operator is thus enabled to see at a glance the operating conditions of his machinery. The location of the control in the wheel-house makes the boat practically one-man controlled, since the engines operate at full speed in one direction at all times.

The scheme of control utilized is the well-known Ward Leonard system, in which the generator field current is varied, thus changing the voltage applied to the propelling motor, the motor being separately excited at a constant value so that its speed and direction of rotation follows very closely the voltage and polarity of the generator supplying power to it. When operating at full power, the two main generators are connected in series by means of knife switches on the engine room switchboard, to the propelling motor. The generator fields are connected in parallel to a reversing rheostat. This rheostat is arranged to receive power at 125 volts from either exciter. The rheostat is made up of two face plates cross connected in such a manner that when the contact arms are in the neutral position, there is no voltage impressed across the generator fields.

As the contact arms are moved in one direction, voltage is applied in gradual steps to the generator fields, thus building up the generator terminal voltage. When the contact arms are turned in the other direction from the neutral position, the polarity of the supply to the generator field is reversed, thus reversing the polarity of the main generator terminals and the current flow through the propelling motor circuit. This rheostat might then be called the master controller as it completely controls the propelling motor in starting, stopping, reversing and speed adjustment. The rheostat is arranged with 60 contacts giving 30 speed points either ahead or astern, thus making the speed adjustment and control very flexible.

The rheostat is located in a compartment beneath the wheel-house deck, and is operated through shafts and bevel gears from the vertical control lever on the pedestal in the wheel-house, or from a hand wheel on the engine-room board. The control lever on the pedestal moves through an angle of approximately 45° from the vertical position to the full speed ahead point, and through an equal angle in the opposite direction from the vertical position to the full speed astern point. This gives the operator a very simple controller and at the same time gives him full control of the boat. The



Westinghouse propelling motor, generating set, excitor, and control pedestal of the stern-wheeler "J. B. Battle."

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engineer's duty then becomes only to keep the main engines running at constant speed, and all manouvering, etc., is taken care of by the operator through the electrical transmission.

The exciters have considerable excess capacity over that required for excitation of the propelling machinery and the switchboard is arranged with feeder switches so that the various auxiliaries and lights may be connected to either exciter as desired, and as necessary to balance the load. When the main engines are shut down, the arrangement is such that lights and small auxiliaries may be operated from 7-½kw. auxiliary generator

All of the auxiliaries on this little vessel are electrically driven. They consist of an auxiliary air-compressor for charging the starting-air bottles for the main engines for initial starting after a long shut-down, a capstan installed on the forward deck, a sanitary pump with automatic control for providing a constant pressure in the sanitary tank at all times, a fuel oil-pump, a fresh water pump, and a fire and bilge pump. The latter is of the Northern Fire Apparatus Company's rotary type with 165 gallon per minute and 60 pounds working pressure. On the forward deck there is an electrically driven capstan of Hyde Windlass make, with a drum type controller on the forward end of the deck-house. This capstan can exert a line pull of 6,000 pounds at 15 ft. per minute. Located in the wing compartment at the after end of the engine-room are the fuel-oil tanks of 1,600 gallons capacity served by a fuel-oil system devised by the Maritime Hydraulic Oil Service, which instantly replaces fuel-oil when used with water, thus maintaining a constant pressure of the fuel-oil supply.

It remains to be seen whether this system will be satisfactory in a river vessel, due to impurities in the river water, etc. To our mind it would seem advisable to install a centrifugal separator between the fuel tanks and the engine, in order to eliminate the chance of any sand or water entering the working cylinders of the engine, or clogging the injection nozzles.

During her trials in December, the vessel was pronounced highly successful, and the propelling machinery performed to the satisfaction of everyone concerned. It is believed that considerable valuable data will be obtained by the United States Engineers during the operation of this new boat. It is believed that the many advantages of this system of propulsion will be demonstrated to such an extent that there will be many more of this type of vessel built in the near future.

The results of her trials are shown in the following table:—

	¼ revolutions; Run No. 1 UP	½ Revolutions		¾ Revolutions			Full Revolutions			
		Run No. 2 DN	Run No. 3 UP	Run No. 3 Corrected	Run No. 4 DN	Run No. 5 UP	Run No. 5 Corrected	Run No. 6 DN	Run No. 7 UP	Run No. 7 Corrected
Time	41.5	9.72	15.94	14.14	7.32	9.59	9.43	6.01	7.32	7.366
Total wheel revolution	197.	100.	146.07	.....	114.	147.	.....	126.	155.	.....
Wheel R. P. M	4.75	10.32	9.16	10.32	15.63	15.37	15.63	21.07	21.2	21.07
Speed	1.445	6.173	3.764	4.243	8.196	6.256	6.360	9.983	8.197	8 185
Current	(.96)	.965	.....	.....	.963	.....	.....	.969	.....	.....
Speed of boat	2.4	5.2	4.74	.....	7.23	7.22	.....	9.01	9.16	.....
K. W. Hrs. to main	2.85	3.5	4.75	.....	6.75	8.25	.....	13.5	17.5	.....
H. P. to main motor	5.53h.p.	29.0	23.9	.....	74.3	69.2	.....	181 h.p.	192 h.p.	.....
Motor, H. P., efficiency about 93%	5.13	26.9	22.3	.....	69.	64.5	.....	168	176	.....
Excitation load, H. P., exciter No. 1	2.8	3.9	3.9	.....	4.39	4.25	.....	5.75	5.7	.....
Total H. P. for main drive	8.33	32.9	27.8	.....	78.69	73.45	.....	186.75	197.75	.....
Average H. P. for auxiliaries	2-0	2-0	2-0	.....	2-0	2-0	.....	2-0	2-05	.....
Total H. P. generator	10.33	34.9	29.8	.....	80.69	75.45	.....	188.75	199.75	.....
Wheel shaft H. P., estimate 10% loss front motor	4.61	24.21	20.7	.....	62.1	58.05	.....	151.2	158.4	.....

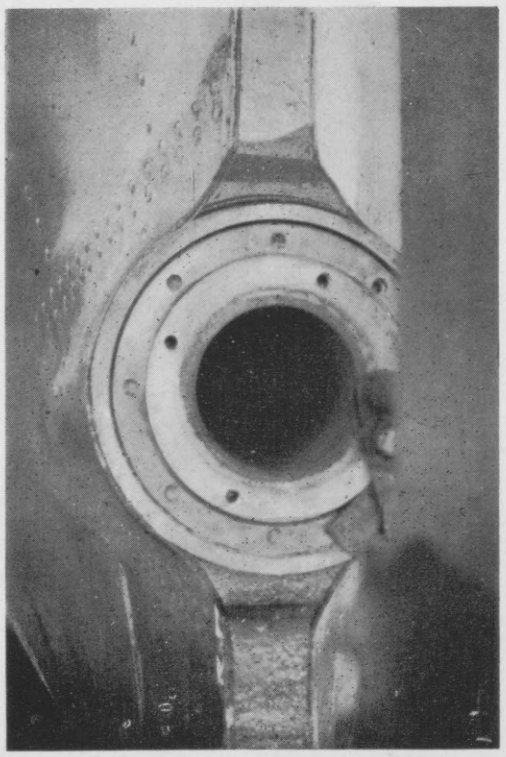
Lignum-Vitae Obsolete For Stern Bearings

Introduction of New Rubber Bearing is Displacing Hard Wood and White Metal for Stern-Tubes on Small and Large Motor Craft

SINCE Columbus first made his discovery of the Western Hemisphere, the product known as india-rubber has been of inestimable value to the progress of civilization, particularly since the advent of the internal-combustion engine. A Western inventor, C. Frederick Sherwood, a man whose personal experiences we have found most varied and interesting, recently came forward with an application of this substance that at first thought may seem impractical to the extent of being ridiculous, namely, bearings for stern-tubes of motorships, motor workboats and steamers; also for pumps, and for all bearing conditions where water may be used as a lubricant.

In the September 1922 issue of MOTORSHIP mention was made of the installation of a rubber stern-bearing replacing the usual babbitted bearing on a Diesel-powered tug designed by David W. Dickie for the State Harbor Commissioners of California. The installation of the rubber bearing at that time was a new and practically untried experiment in marine design. But it has given perfect success. On the installation being examined after ten months of service, no signs of wear were shown on either the bearing or the shaft. It has been in continuous use ever since, operating in the grit and sand of San Francisco Bay.

Since that time the exclusive manufacture and sale of these bearings has been taken over by the B. F. Goodrich Company, Akron, Ohio, who have been industriously exploiting their use in the marine field under the trade name Cutless. Numerous installations on the Atlantic seaboard on both pleasure and work craft have been made; one of the more recent ones being by the Standard Oil Company of N. J. in their new Diesel-electric driven barge No. 8, recently launched at Newport News, Va. The Standard Oil Company's engineers installed this rubber bearing after having operated a motor-barge in the Baltimore district under the most severe conditions, under which the bearings stood up perfectly.



Showing the rubber bearing in the stern tube of the new Diesel-electric tanker building at Newport News for Standard Oil Co. of New Jersey.

While the actual use of rubber bearings in the marine field is only about two years old, these bearings have had four years of actual operation in the pump field. Such firms as the Worthington Pump & Machine Company, Chicago Pump Company and many others have adopted them as standard equipment on their pumps. It has been demonstrated time and time again that there is no substance that will stand the wear that rubber will. Rubber bearings have carried loads as high as 375 lbs. per sq. inch projected bearing surface, and a wetted rubber surface has a lower co-efficient of friction than an oiled babbit surface. Also, it has been absolutely demonstrated that no amount of grit or sand will either cut the bearing, or score the shaft that operates in the bearing. This is due to the fact that it is impossible to imbed a piece of sand or grit in the soft rubber surface of the bearing, consequently, the sand or grit is rolled to a deep spiral groove in the rubber by the shaft, and is washed out by the water which also circulates through the grooves. Rubber bearings necessarily need water for their lubrication.

The spiral groove referred to runs the entire length of the bearing, and while providing a channel for the lubricant to circulate, also carries out any sand or grit

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which may come into the bearing. The surface of the rubber bearing being extremely resilient, the sand or grit cannot be imbedded in the actual bearing surface as just stated, but will roll to the groove, and be carried off. This action is unique only to a rubber bearing.

With a metal bearing the action is quite different. Upon the admission of sand to a metal bearing, in which the bearing surface is softer than the shaft which rotates in it, the sand becomes imbedded in the softer metal. The bearing then acts as a holding-tool for the sand or silicious matter, which then exerts a grinding or cutting action upon the rotating shaft.

It has been actually demonstrated in craft operation that the rubber bearing materially reduces screw vibration, cushioning any inequalities of pitch and not transmitting through the whole craft the entire vibration. This tends to longer life for machine operation and reduces the annoying screw vibration sometimes found in power craft. Rubber bearings in service are operating on speeds as high as 5,000 r.p.m. and as low as one revolution in three minutes.

It is a remarkable fact that misalignment of a shaft carried in a rubber bearing under high load is extremely small. Another feature of the rubber bearing permits a shaft that is misaligned to operate without pound or noise. A misaligned shaft operating in a mental bearing soon elongates the bearing. Permanent deformation of a rubber bearing is impossible, owning to the resiliency of the bearing surface. When operating on a misaligned shaft, the rubber bearing acts as a shock absorber, and prevents undue vibration being transmitted throughout the length of the shaft.

McIntosh & Seymour-Westinghouse Diesel-electric tanker "J. H. Senior" just after her recent launch at the Newport News Shipbuilding & Dry Dock Co., Newport News, Va. to the order of the Standard Oil Co. of N. J.

The Goodrich Cutless bearing as now on the market consists of a drawn-metal cylinder with longitudinal corrugations on the interior. Cement and a hard rubber coating are then placed next as a lining in the tube, followed with not less than 5/16 of an inch of a specially compounded highly resilient Olivite rubber. The rubber is vulcanized to the shell under pressure. After vulcanization, the bearing is ground through with a high-speed grinding wheel. A speed of not less than 18,000 r.p.m., is found to be necessary in this connection. The spiral groove is also ground in the bearing during this operation. The finished bearing is then ready for installation.

The largest bearing operating to date, of this character, is three feet in diameter, by six feet length, and operates on a hydraulic turbine in the Mississippi River Valley. The introduction of these bearings to the marine field is rapidly progressing, and one of the foremost naval architects predicts that within five years the rubber bearing will replace the standard lignum-vitae bearing now in use on all craft.

Cutless rubber-bearings are made of particularly pure compounded, high-grade rubber stock, compounding of which must necessarily be extremely exact so as to permit of the longevity under all conditions. They are, we understand, actually guaranteed to give four times the life of any other bearing now being used in the marine field, including lignum vitae, which has a practically identical cost. The B. F. Goodrich Rubber Company handles these bearings in over one hundred agencies in the United States. They are now manufacturing these bearings in France, and through their affiliations, in England and Germany.

In reference to the longevity of rubber under extreme wearing conditions, it might be mentioned that King George's court, London, is paved with rubber, and has stood thirty-eight years of wear. During the entire period, the maximum wear shown on this surface is only one-eighth inch.

America's Highest Powered Diesel Motor Tug

What is believed to be the largest and highest-powered Diesel-engined tug-boat in this country, the JUMBO, recently arrived in New York City, following her completion by the New London Ship & Engine Co., of Groton, Conn. The JUMBO is 100 ft. long, by 26 ft. breadth, 10 ft. draft forward and 12 ft. draft aft. She is equipped with a six-cylinder, direct-reversible Nelseco four-cycle type Diesel-engine of 600 shaft h.p. This has been found to give the craft a speed, when running light, of about 13½ knots. She will be engaged in the service of the Transon Marine Corporation, 5 Nassau St., New York City, in the New York district towing in the harbor, off the coast and river work. The vessel is to be operated 24 hours per day, and has a crew consisting of 9 men, but sleeping quarters are provided for 12 men. Her fuel-tank capacity is 333 bbls, giving a radius of action of 350 hours at full power. At an early date we shall give more information.

American highest powered tug "Jumbo," a 100 footer, propelled by a 600 shaft h. p. Nelesco reversible Diesel engine, which recently arrived in New York.

Two More Golden Gate Diesel-Electric Ferries

Following the placing in service of the Pacific Werkspoor-General Electric equipped Diesel-electric ferries for the Golden Gate Ferry Co., of San Francisco, we mentioned that a third ship would shortly be ordered. However, the Golden Gate Ferry Co. has placed contracts for two more steel hull double-ended ferry vessels, which will be somewhat larger than the previous craft. Instead of two main generating sets there will be three Pacific Werkspoor Diesel engines, each direct connected to a General Electric 270 K.W. 250 volt D.C. generator. On the extension of each main generator shaft there is a 30 kilowatt auxiliary generator. The Diesel engines are each of 400 b.h.p. Mounted at each end of the boats and direct-connected to the fore and aft propeller shafts respectively, are two 750 volt, 950 shaft h.p. motors at 180 r.p.m.

When completed the new ferry vessels will operate between Sausalito and San Francisco, releasing the two previous Diesel-electric craft for serving new routes.

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Motorship

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Congressional Action on the Steamer Conversion Question

ON ANOTHER page we reproduce an amendment to Sections 11 and 12 of the Jones' Merchant Marine Act of 1920. This amendment was drafted by a special subcommittee of the House Committee on Merchant Marine and Fisheries following a lengthy hearing of the various shipbuilding and shipping interests of the country at Washington, D. C., parts of which hearing we reproduce verbatim on other pages. The amendment has been reported to the House of Representatives with the recommendation that it be enacted into law at the earliest possible time.

Never any time previous has there been a tendency of Congress to take such a practical step to put the Merchant Marine on a competitive basis with the more cheaply operated and constructed fleets of foreign nations. Vast sums appropriated by Congress in the past to build up the Merchant Marine have been almost useless as the vessels constructed under these funds were too inefficient to compete successfully on the high seas. True, building a huge fleet was largely a war-time measure, but a vast amount of construction has continued for two years following the war without any attempt to change the plans and bring the vessels up-to-date. Responsibility for this rests on the ex-Chairman Hurley and the Board with him at the time, who while publicly acclaiming the importance of oil-engine power, took no active steps to see that the same were installed in the vessels building under his jurisdiction.

But what was done is past, and there now is every indication that Congress will approve of the Greene amendment which will rectify past mistakes as far as is possible, by providing funds for the conversion of a large number of these ships to economical Diesel power; although there probably will be minor changes from the draft as published in this issue. The Board will convert 50 ships using $25,000,000 of the $125,000,000 fund for this purpose.

Fifty Dollars Per Ton Offered

WITH the Board's cargo *steamers* on the market at approximately $30 per ton, considerable significance may be attached to the offer of $606,000 or $50 a ton received for the *motorship* WILLIAM PENN when the bids were recently opened in Washington. It demonstrates that there is at least one firm of American shipowners who are fully conversant with the much greater earning capacity of Diesel drive.

From One Country to Another

CONSIDERABLE perturbation has arisen in Holland because the Netherland Steamship Company, a government subsidized concern, has placed a contract with a French shipyard for the construction of a 14,000 gross tons twin-screw passenger and mail motorship to be fitted with Diesel engines aggregating 8,000 s. h. p. The chief reason of this is that the French prices are about 25 per cent. less than the Dutch; but it must not be overlooked that few shipyards in Holland have had sufficient experience to handle the big technical task of the construction of a motorship of this size and power.

In the past the shipbuilders in Holland, as well as shipowners, have been almost ultra-conservative, with the result that until last year the Diesel engine had made very little headway in that country, with the exception of that developed by the Werkspoor Company, which was one of the first to install oil-engines in ships. Their engines, however, have mostly been ordered by shipowners of other countries. The Dutch, although conservative, nevertheless form some of the most keen business men in the world and once they are satisfied do not hesitate vigorously to forge ahead. Consequently, there lately has been almost a rush among the leading Dutch shipyards to build Diesel engines, as witness the licenses just taken by the De Schelde, the Fijenoord and Burgerhout shipyards, and by orders for big motorships and conversions since placed by the leading Dutch shipowners.

From all this is sounded a note of warning to those American shipbuilders and shipowners who are still unconvinced of the economical superiority of the oil-engine, regardless of its higher first price. Had Dutch and American shipyards and shipowners taken up the Diesel engine with keener avidity in the past, the cost of production would undoubtedly be lower to-day, and development costs written off their books, which would have enabled them to come nearer to other countries' bids than they can do at present. In our own shipyards cost of manufacture is much higher than it would be had any quantity production been existent and had major development costs been written off. The latter is the only way in which the cost of building Diesel engines in the United States can be percetibly reduced. At the present time this type of machinery is 30 percent to 35 percent higher than that of steam, and from 40 percent to 60 percent higher than European Diesel engines. With the result that during the last 15 months Americans have ordered the surprising total of 36,500 horsepower in marine and stationary oil-engines from European builders. Quantity production would enable these prices to be reduced by at least 15 percent and possibly 20 percent. The chief engineer of one American shipyard recently told the House Committee on Merchant Marine that he believed quantity production of ten engines at a time would enable the prices to be reduced by as much as 35 percent.

Will America Remain Seated on the Fence?

IN ITS issue of January 3rd the Liverpool Journal of Commerce refers to the remarkable development that has recently taken place in Great Britain in the construction of Diesel-driven motorships. Notwithstanding the handicap of the shipyard lockouts, British yards put into the waters motorships representing over 100,000 tons d. w. out of a world total of less than 400,000 tons. This achievement is enhanced by the fact that in the application of the modern internal-combustion engine to large ships of the liner class the lead has been definitely taken by Great Britain.

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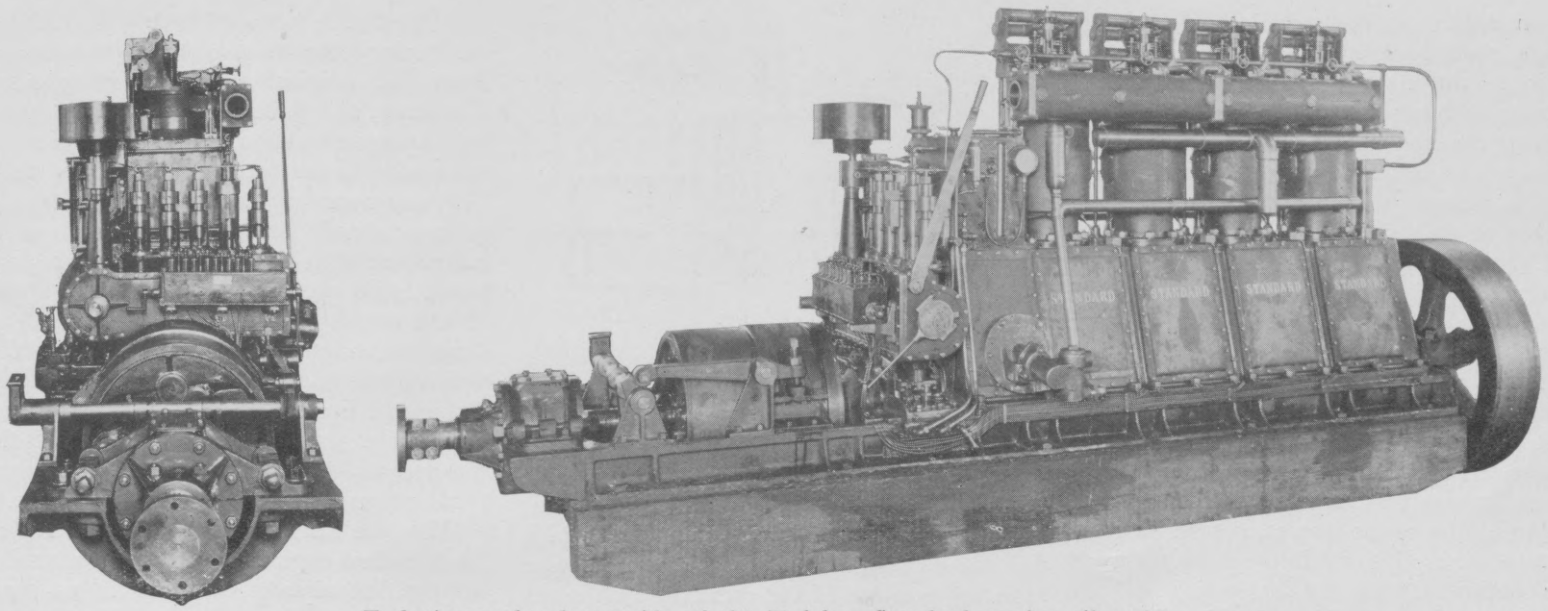


End view and exhaust side of the 70 b.h.p. Standard marine oil-engine.

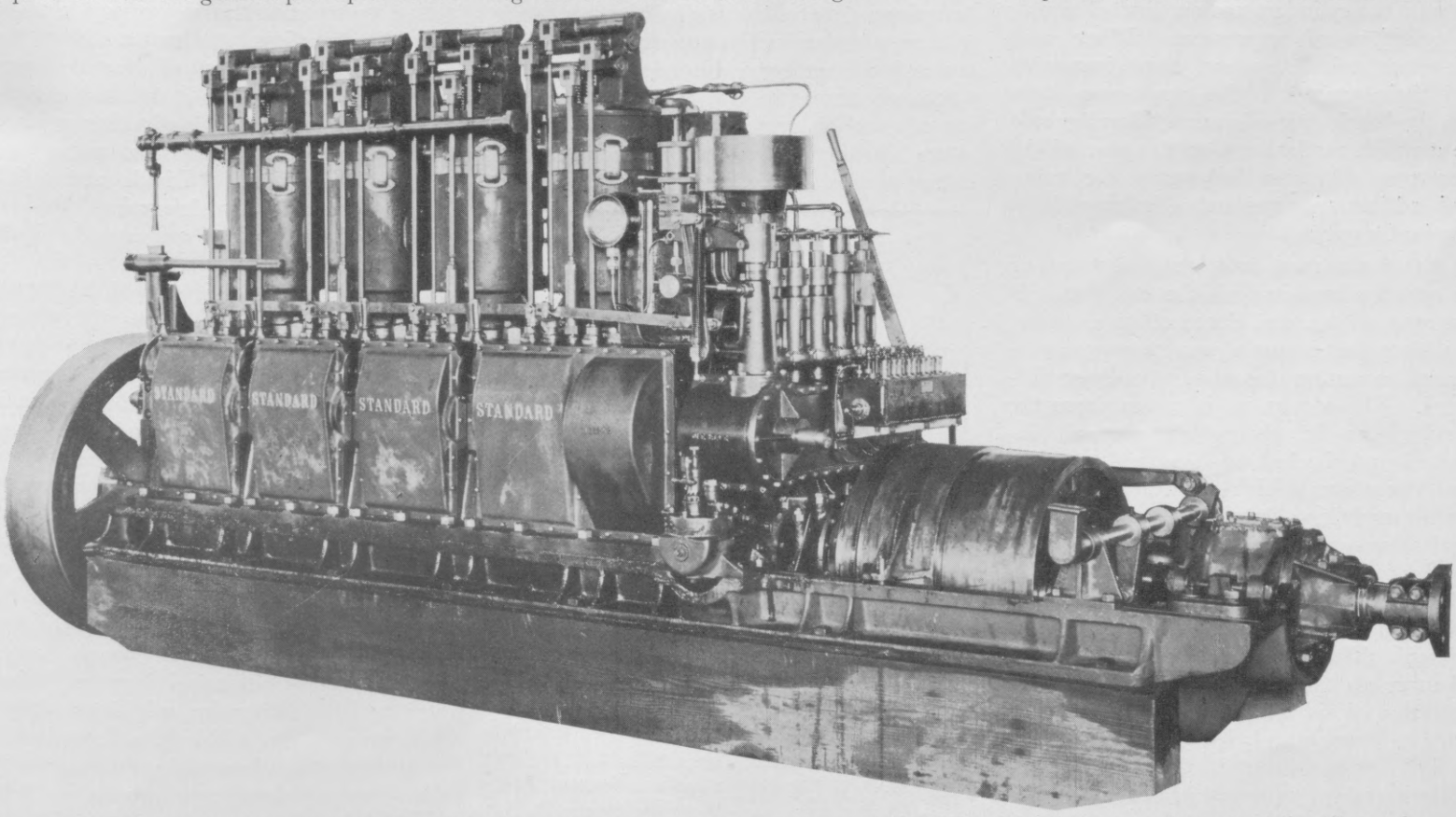
America's Newest Workboat Engine

Development Along Lines of Well-Established Practice with Incorporation of Original Features, is Followed in Production of Standard Oil Engine

TO marine internal-combustion engineers The Standard Motor Construction Co. hardly needs an introduction. It will be remembered that it was they who first tackled the problem of producing gasolene engines of very large power for marine purposes, and that at one time they dominated this field with their 300 b.h.p. and 600 b.h.p. double-acting motors. Had not the advent of the heavy-oil engine put an abrupt end to the use of gasolene for nearly all machines of this class, they would in all probability continue to be among the leaders in it. Their adoption of the oil engine, besides being a sign of the times, is characteristic, also, of the versatility and attainments of their engineering staff.

The oil-engine public has already become acquainted with the general principles of the type that the Standard Company has chosen, since it does not differ materially in principle from the Vickers airless-injection principle as embodied in such well-known and successful machines as Atlas-Imperial, Enterprise, and others. By thus avoiding new and radical departures, and by concentrating upon a pains-taking work-out of mechanical detail, they give evidence of a degree of insight into the actualities of the oil-engine game such as is frequently lacking in less seasoned undertakings.

A very good general idea of their 70-BHP four-cylinder 8″ x 10″ type may be gotten from the appended illustrations; many readers of "MOTORSHIP," no doubt, inspected the engine itself with keen interest when it made its debut at the Motorboat Show recently held in New York City. The framing consists of a massive bedplate extended in one piece to a length sufficient for accommodating the reverse gear and clutch. Surmounting the same is a box-frame crank-case suggesting the usual type of construction, but different from the latter in that unusual efforts have been made to insure that a man can accomplish something else inside of it besides getting himself dirty. The crank-case doors visible from the outside are unusually large; and although no compromise, we are told, has been admitted



Inlet side of new Standard oil-engine. The three-stage fuel pumps, governor, and the McCord lubricators can be seen at the after end.

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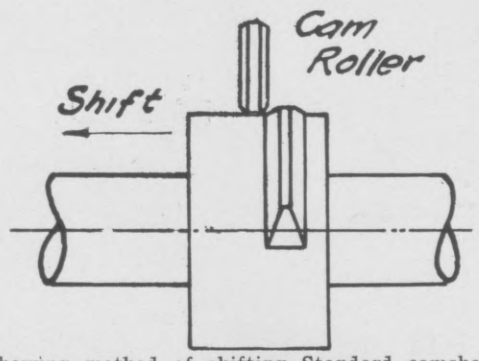
of in regard to the question of strength, ample room is also provided to work at the main bearings. These are of babbit-lined bronze and can be rolled out without removing the crankshaft. The transverse bedplate girder which supports the main bearings is securely tied in to the box-frame by means of tie rods running clear through.

Cylinders and their water-jackets are cast integral, surely a logical thing to do with an engine of this or even slightly larger bore. When an independent liner is used, the joint at the top end becomes a massive, cumbersome affair difficult to cool and subject to growth and cracking; but what is worse, some kind of a joint against sea-water leakage inaccessibly located in the interior of the crank-case cannot be avoided. It must be a slip-joint in order to allow for the differences in the expansion of the jacket and liner. Although this might not be a serious matter in a stationary engine or in a marine engine designed to run in fresh water only, the water-joint inside the crank-chamber is surely a liability when it comes to salt-water craft. Salt water entrained in the lubricating oil of the crank-case of a force-feed lubrication engine can never be removed entirely and to get enough of it out for safety is a difficult matter. The integral cylinder adopted by the Standard engineers seals up this source of danger.

Since the water from the cylinder jacket comes to the cylinder heads through an exterior U-shaped casting, no such complicated water-joint need be made up as is the case in designs wherein an attempt is made to lead the water from the jacket-core to the head-core by means of rubber-inserted nipples or a continuous gasket. Making sure that no water can leak into the combustion space is not alone sufficient because the objections to water leakage down the sides of the cylinders are not limited simply by questions of appearance. When such salt-water trickles occur, they invariably find their way past the crank-case doors into the lubricating-oil sump. Barring only the grossest carelessness on the part of the operators, salt-water leakage at the cylinder-head joints is completely eliminated from Standard engines.

One of the most interesting features of the cylinder head itself is the fact that it is cast open on top, and closed off at assembly by a plate that forms a convenient and substantial mounting for the valve-lever fulcrums. The casting as it comes from the foundry can be thoroughly cleaned, inspected, and checked up in regard to thickness, operations which are rendered more difficult and less certain in heads of the usual closed-core type. Should salt deposits ever be formed, they can be removed with a degree of ease that compares favorably with the accustomed manipulations of wires and acid. The integral valve-lever fulcrum and cover-plate suggest rigidity and strength, properties of no mean importance when it comes to precise and delicate operation of the airless-injection spray needle.

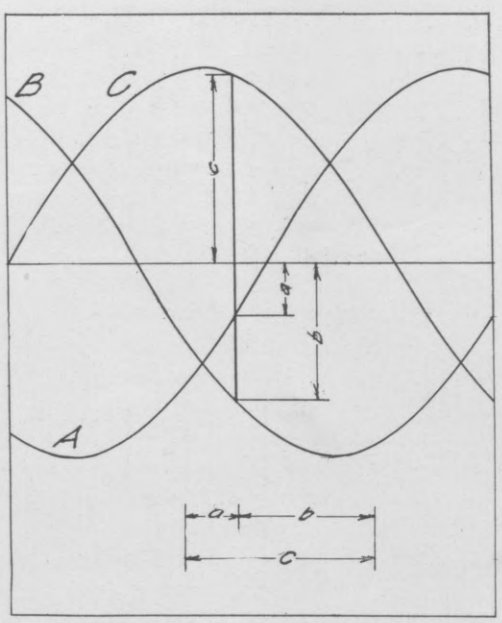
Starting the engine is accomplished by means of amazingly low air pressure—



Showing method of shifting Standard camshaft for starting on compressed air at 60 lbs. per sq. in.

60 lbs. per sq. in. against a compression of 350 lbs. The camshaft is "slidably" mounted; cam and roller edges are beveled to permit of lateral engagement, an example of which we show diagrammatically. In the extreme starting position of the camshaft fuel is cut out, compression is relieved, and a starting cam of unusually long duration is brought into engagement. On a part of the return movement of the camshaft back to the normal running position, full compression is restored while fuel injection commences and starting-air is still being supplied and at the end of the movement the latter, too, is cut out. This is all accomplished by a simple movement of a hand lever and the operator needs hardly to be conscious of the fact that there is such a thing as an intermediate position in which air and fuel are being supplied without compression relief. The engine attains a speed adequate for ignition in a remarkably short space of time and it takes only an instant to shift the hand lever back into the running position.

As regards regular operation, the salient features of the Standard design are of course embodied in its fuel-supply system. A simple low-pressure pump that involves no very great outlay either in manufacture or upkeep elevates the fuel oil from a sump to a rectangular fuel box containing strainers and the unused excess as well as the discharge from the spring-loaded by-pass are allowed to return via the box to the sump. From the fuel box the actual fuel-pump of the engine, which is fitted with



The Motion of the Standard Three-Plunger Fuel Pumps is such that No Accumulator is required.

three plungers, takes its suction and herein lies perhaps the most significant departure from the original Vickers arrangement. The latter, as will be remembered, employed only a single plunger pump having an accumulator in the form of a Bourdon tube. This was necessary not so much to keep the pressure steady between close limits as to make sure that those needles which happened to be open during the suction stroke of the single plunger would have at least some pressure behind them. To do this positively required an accumulator so large that in the event of a leaky needle dangerously large quantities of fuel might be discharged at high pressure into the affected cylinder, possibly causing heavy damage.

With the three-cylinder pump found on the Standard engines and those of a similar construction already referred to, no accumulator is necessary beyond the storage capacity represented by the elasticity of the tubing walls and the entrained air. Ordinary geared triplex-pumps in which the motion of the plungers is approximately harmonic are well known for the smoothness of their delivery for the simple reason that the algebraic sum of any three harmonic functions having the same amplitude and phases differing by 120° is always zero. This will be at once evident to the eye from an inspection of the curve given, in which A, B, and C represent the velocities of the three plungers. Any two ordinates such as a and b add up to a sum that is equal and opposite to the third ordinate, c.

As has already been mentioned, a separate elevating pump keeps the three suctions of the forcing pump supplied with fuel under the head represented by the height of the level in the fuel box; suction uncertainties, the biggest bugbear of all pumping problems, are, therefore, eliminated. Nor is the forcing pump called upon for any kind of measuring function. At least a part of the delicacy and fussiness of the ordinary Diesel engine fuel pump is due to the combined requirements of delivering against heavy pressures and of doing so with a high degree of precision. "Divide and rule" says the proverb; by delegating the fuel measuring function to an entirely independent mechanism — the cams — the design, manufacture, and upkeep of the Standard fuel pumps is reduced to the utmost simplicity. They are called upon merely to maintain the pressure in the "common rail" supplying the fuel valves of the various cylinders. A spring-loaded by-pass valve on the rail automatically maintains a constant pressure, returning excess fuel to the fuel box.

Since the three plungers pump a quantity far beyond that required by the engine at full load, their size is such that they can be ruggedly built and can be served by suction and discharge valves large enough not to require constant attention from a Swiss-watch artist. Minor imperfections simply cut down capacity, which is so large in the first place that a substantial percentage more or less has no significance whatever. The spring-loaded by-pass valve always lifts at

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practically the same pressure, no matter what the quantity of oil discharged may be. Perhaps one of the most cogent reasons why air-injection Diesel engines are not widely built with cylinder bores of 8 inches or less is that the necessary individual fuel-pump plungers shrivel up to a diameter of some 3/16 of an inch and that the valves that go with them must be built and operated by the aid of an opticians' loop.

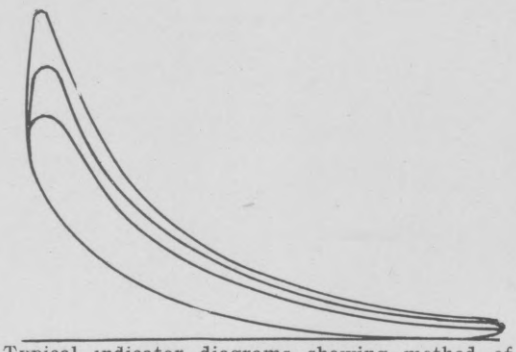
A further substantial gain that results from the use of three plungers instead of one is that the engine can continue to run, even though one of the pumps should leak or be disabled from any cause. An excess of fuel will still be delivered and the resulting pulsations are not serious enough to require shutting down the engine before it is convenient to do so.

The fifth pump, visible at the extreme right-hand side of one of the illustrations, is hand-operated and is used only before starting up to test and prime the injection system. Since it is a duplicate of the regular operating pumps, it can be manufactured on a quantity-production basis along with them and, therefore, involves no great additional expense.

Naturally the question arises as to how fuel distribution and load-control to the individual cylinders is accomplished in an engine equipped with so simple a fuel-pumping mechanism. One picture shows a light but non-yielding tension rod running down from the fuel-valve rocker arm to the camshaft side of the box-frame, in the interior of which it engages the fuel-cam roller through the medium of a clearance-varying device. The spray-valve itself is nothing but a spring-loaded needle; below its seat are five fine orifices and above it is a small passage communicating through the common rail with the spring-loaded by-pass and the fuel pump.

Attention is again drawn to the unusually massive mounting of the rocker lever for actuating the needle; it is lifted through the medium of a ball joint and thereby protected against cramping. A guide of substantial proportions is fitted on the needle at the point where the lever takes hold. All these features assure a degree of positiveness and precision in the operation of the needle such that they may reasonably be expected to overcome all objections that might possibly arise out of the minuteness of the needle lift.

Both the equal apportionment of fuel supplied to individual cylinders as well as the load on the entire engine are carried out by the simple expedient of varying the fuel-roller clearance by means of the crank-device visible in the photographs. These are capable of individual setting for load-equalization on the various cylinders and also receive a movement that is common to all from the governor-actuated rail running along the front of the engine. Bringing the fuel rollers closer to the cams increases the lift and duration of the needle opening, while the engine responds to an increase of load. The timing of course is also affected by changing the roller clearance; but as the



Typical indicator diagrams showing method of varying load on Standard engines.

entire lift is exceedingly small, the angular change in the point of roller incidence upon the cam is negligible. At any rate, the timing advances as the load increases and as we are dealing with a marine engine, advances in load, speed, and therefore also timing all go together. The kind of regulation that results from this procedure is illustrated in a general way on this page. At the extreme left-hand side is shown the constant volume line of combustion, which is vertical and has its greatest length at full load and speed. As the engine is slowed down, injection begins a trifle later, thereby imparting a slope to the combustion line and rounding off its peak.

The governor is amply proportioned and as the method of regulation just described imposes no back-pressure upon it, maintains even running under all conditions. Speed variation is accomplished by varying the tension of the governor spring and good control while clutching or declutching as well as during other manoeuvers is at all times assured.

Other features worthy of note are the circulating water pump, which is applied in such a way that the drip from it cannot possibly get into the lubricating system and which is fitted with a guide independent of the gland for taking the side thrust of the eccentric rod. Cylinder lubrication is effected by means of individual fresh-oil pumps. Besides the usual pump for forced lubrication of the drilled crankshaft and connecting rods, there is a special oil pump which pumps lubricating oil from the bedplate through a strainer into the suction chamber of the main pump. This feature alone would give evidence of the care and thoughtfulness with which the Standard designers have handled every detail of their machine. The ones which we have been able to describe here are only a fraction of the total which make up an excellent engine.

Powell River Co. Orders Motor Tug

The Powell River Co., one of the largest manufacturers of wood pulp and paper on the British Columbia coast, is having an oil engine tug built by W. Menchion's shipyard at Vancouver, B. C., for use at their Powell River plant. The new tug is 56 feet over all by 14 feet 6 inches beam and 7 feet draft. She will be equipped with a three cylinder, 110 h.p., Union Diesel engine, the first of the new airless-injection design to be installed at Vancouver. The Powell River Co. has had some years experience with oil engines. N. R. Lang, the manager of this company, uses a beautifully fitted-up power cruiser, the NORSAL, of 135 feet over all, equipped with twin 200 h.p. Fairbanks Morse oil-engines; while a 75 foot power cruiser the GRETA M used by Mr. S. B. Brooks of the Powell River Co. largely for timber inspection work is equipped with a 75 h.p. Fairbanks Morse oil-engine.

Oil Engine Manufacturers' Census

Will every oil-engine builder in the United States kindly send in, as soon as possible, to the Bureau of Census, Division of Manufacturers, Department of Commerce, Washington, D. C., the number of marine and stationary oil-engines and horsepower manufactured during 1923? Up to 1919 the census of manufacturers has been taken at five-year intervals, but a biennial investigation has been authorized beginning with the year 1921. That year was the first in which oil-engines were segregated from other types of internal-combustion units: The Department of Commerce is now working on the census of manufacturers for 1923, and desires all manufacturers to make early returns to the Bureau.

246 Atlas-Imperial Diesel Engines Sold in 8 Years

The market in this country for marine and stationary oil-engines from 25 b.h.p. to 500 b.h.p. is growing rapidly. A good indication of how tremendous this market is becoming, is shown by the output during eight years of manufacture of the Atlas-Imperial Diesel Engine Co., of Oakland, Calif., which is as follows:

Number of engines..	246
Power (total)	23,216 h.p.

It will be seen from the above list that the output during eight years consists of 246 engines of 23,216 h.p. If an approximate value of $75 per horsepower is assumed, the total amounts to $1,741,200. Over one-third of these engines were built during 1923.

Opens New York Office

R. R. Row, formerly with Row & Davis, engineers, has opened an office at 30 Church St., New York, as advisory and sales engineer. He will be glad to hear from old business friends.

Aimé Dumaine Honored by France

Because of services to France, Aimé Dumaine, head of the New York office of Schneider et Cie., the famous French gun makers, and Diesel-engine builders, has been honored by the French Government by being made a Knight of the Legion of Honor. Mr. Dumaine is also secretary of the Franco-American Industrial Corporation, 21 East 40th St., which is the American subsidiary of Schneider & Co. He has been identified with the Schneider interests of Le Creusot for the past 22 years.

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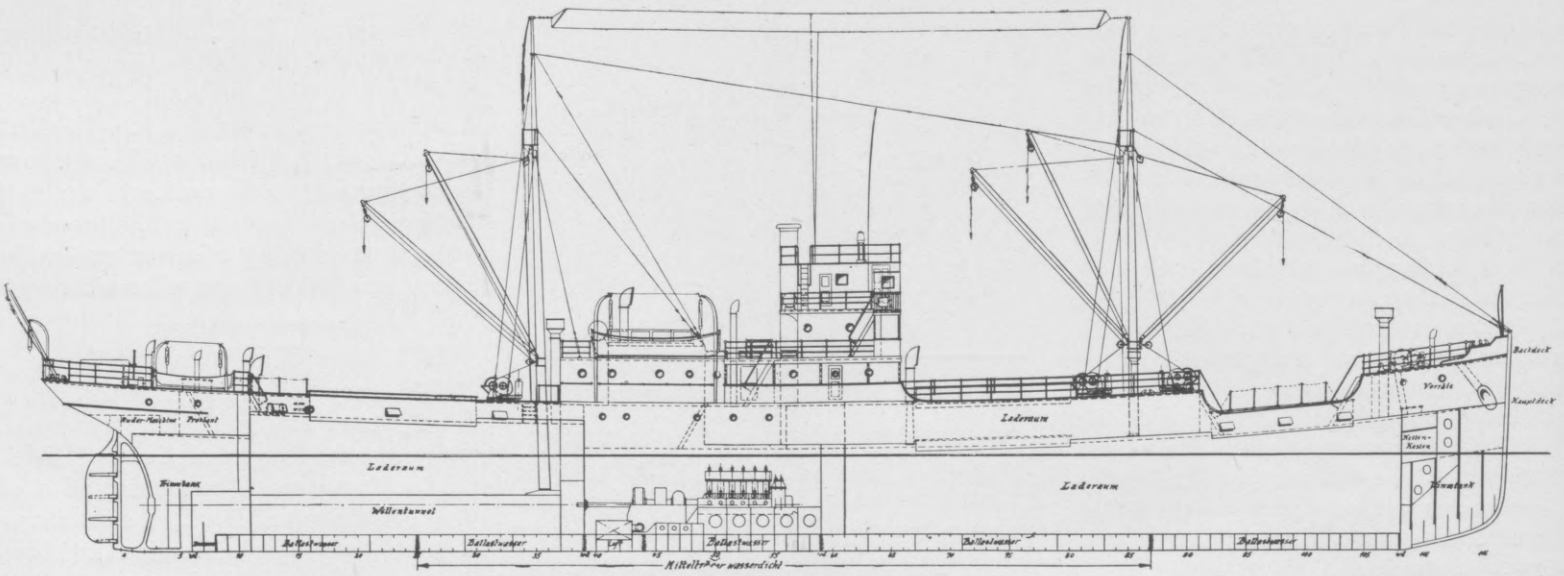


A 2,000 tons German cargo motorship now completing, showing Diesel engines in conjunction with reduction gears and Foettinger transformers.

Hydro-Mechanical Transmission For Motorships

Vulcan Werke of Hamburg Develop Hydraulic Transformer Combined with Single Reduction Gear

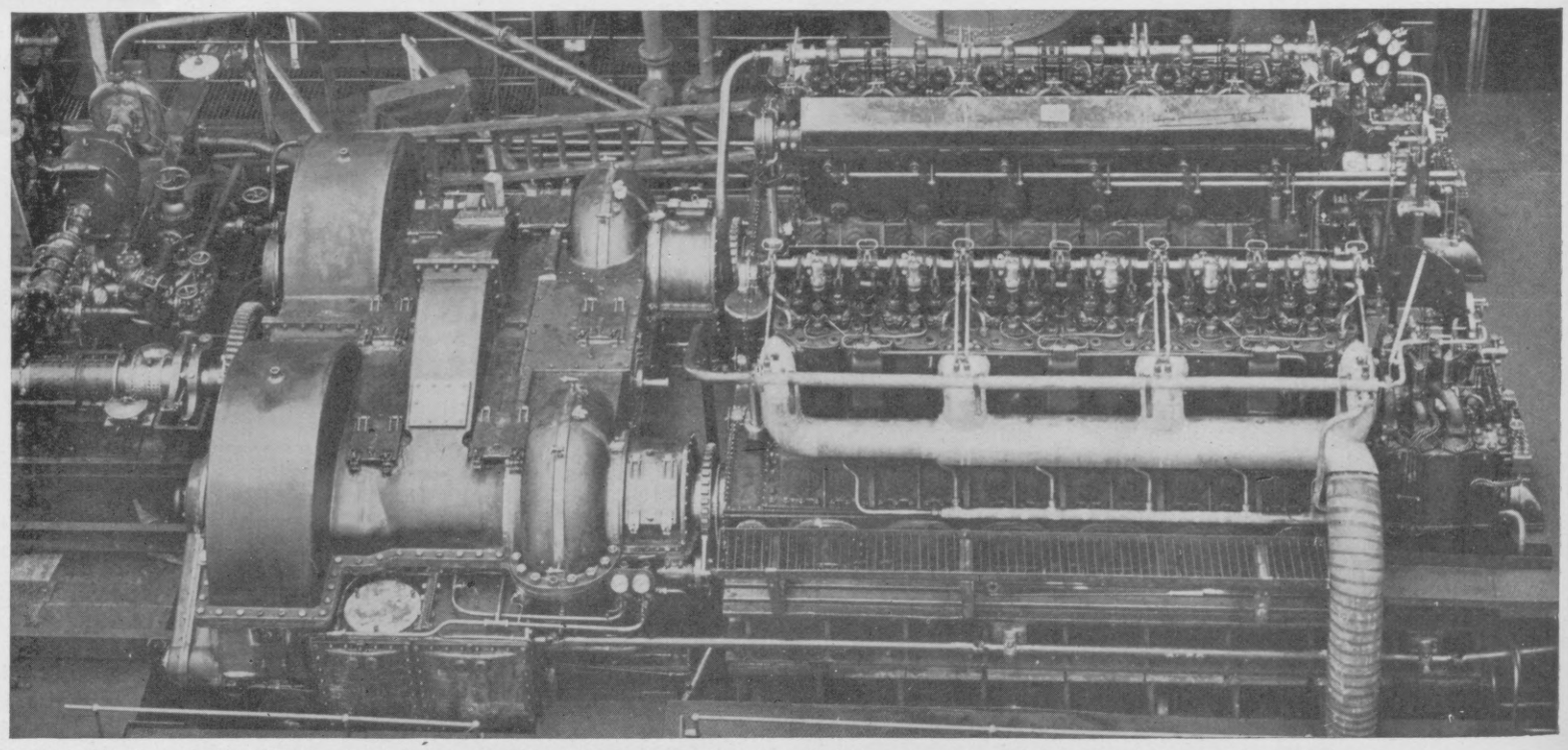
SO MUCH has been written and spoken about the use of light high-speed heavy-oil engines for the propulsion of large cargo ships that any really novel contribution to the subject such as nas just been communicated to us from the Vulcan Werke will surely command the interest of all who are in any way concerned with the subject. Particularly significant, it seems to us, is the fact that this important German shipbuilding and engineering concern recently were engaged in the construction of an 1,800 b.h.p. slow-speed Augsburg two-cycle Diesel engine, so that their apparently radical conversion to the high-speed idea is all the more remarkable. Whereas this machine was designed to run at 100 r.p.m., the oil engines which they now appear to be advocating in connection with their hydro-mechanical drive, and which will be subjected to trials near the end of this month in a newly completed ship, turns up around 300 r.p.m.

In addition to the large passenger liner in which the original Foettinger hydraulic-transformer was tried out prior to the World war as a means for gearing down Parsons turbines, an application to internal-combustion engine propulsion was also made at about the same time by A. C. Holzapfel on a small producer-gas engined British coastwise ship known as the HOLZAPFEL I. She was in service two years, made 23 coast-wise voyages with cargo and finally had her entire power-plant replaced with steam.

The new element introduced into this form of transmission by the Vulcan Werke consists of the single reduction-gear shown in the line drawing. The pinion B is hollow and can turn freely on the engine shaft (not visible) running through the entire system. Keyed to this shaft are the driving impellers of both the ahead and the astern units H, whereas the rotors C, which are driven by the oil that is set in moiton by the impellers, are rigidly fastened to sleeve extensions on either side of the pinion A. Either of the elements (ahead and astern) may be filled by a system of pumps under the control of the maneuvering gear, so that a variable speed in either direction may be imparted to the pinion B while the oil engine remains under the control of the governor.

It is interesting to note that a simple skew-gear is used in place of the herring-bone wheel, the side thrust from which we presume is balanced by an axiaul reaction on the blades of the driven rotor. Since this balance cannot be perfect at all speeds, thrust rings are provided on either side of the pinion to make up the difference.

Since the gears as well as the hydraulic



The first Diesel engined reduction-gear drive with Foettinger hydraulic reversing transformers which replace the usual mechanical reverse gear on an engine. Each engine is of 620 s.h.p. at 300 r.p.m.

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transformer are accommodated in the same casing, oil is used as the working fluid, although, we are informed, it is possible also to make a partition if it is desired to use water for the transformer. Pumping oil by means of a centrifugal pump is a novelty and the operation of what is essentially a hydraulic turbine by means of flowing oil is also a matter about which we would like to be able to inform our readers more specifically. Although we have not seen actual test reports, we are informed that the hydro-mechanical gear was set up and exhaustively tested at the Vulcan shops under the supervision of a member of the teaching staff from a prominent German technical college. A quadruple check as to efficiency was made as follows:

1. While the coupling was arranged to transmit power from a high-speed Diesel engine to a water-brake, the engine was indicated and the turning moment on the brake-arm weighed.

2. Electrical measurements were made from a motor and generator of which the former was driving the latter through the medium of the coupling.

3. Readings were taken from two torsion meters, one fitted to the primary, and the other to the secondary shaft of the coupling.

4. The rise in the temperature of the working fluid was used as a basis for calculating the friction losses in the coupling.

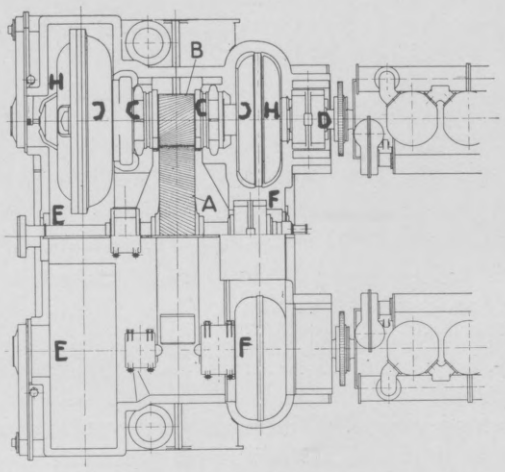
The range of powers and speeds covered was from 150 to 320 r.p.m. and from 100 to 300 h.p., with conclusions reached by Prof. Dr. Ing. Proell as follows:

1. Loss of power is directly proportional to difference between the speed actually obtained and that which corresponds to the pitch of the impellers, that is, to the "slip." Efficency and slip were therefore found to be identical on test and varied between 96 and 97%.

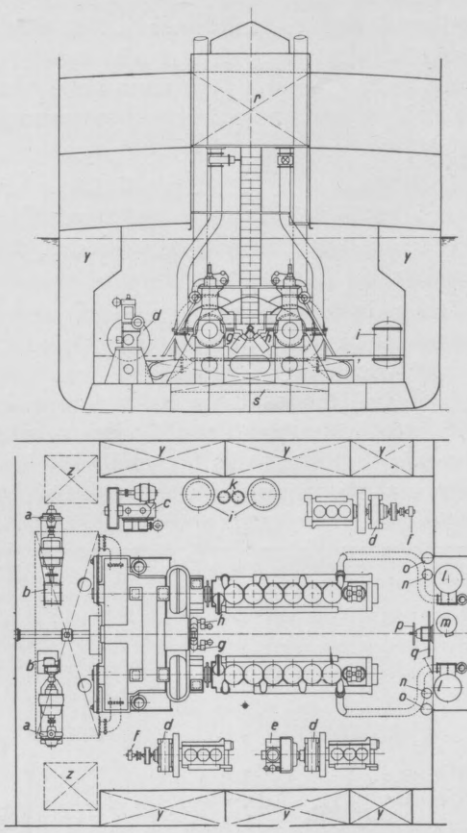
2. Efficiency can be increased indefinitely beyond the figures stated by decreasing the rating of the couplings and is therefore ultimately determined by considerations of weight and space.

Tests have also been made to determine the effectiveness of the coupling as a vibration damper, with the perfect results shown in the torsiographic diagrams reproduced herewith.

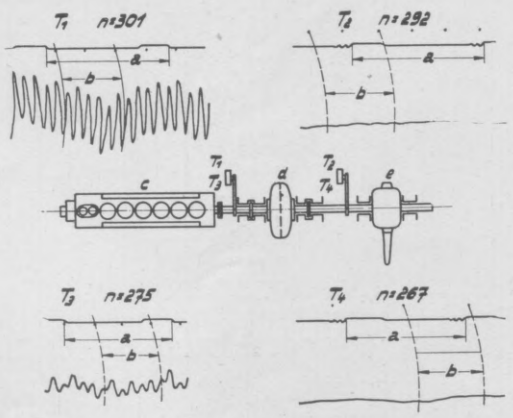
Many of those who read the first accounts of the Foettinger transformer published not long before the World War and who were impressed by the remarkable promise which it seemed to offer, have had occasion to wonder why so attractive a proposition should have fallen into apparent desuetude. It will be recalled that the early published accounts described a device that consisted essentially of a centrifugal pump housed in the same casing as a hydraulic turbine. Instead of a volute, the centrifugal pump had stream-line vanes and passages connected to the guide vanes of the turbine rotor, so that power applied to the pump shaft was transmitted with high efficiency to the turbine. Losses both in pumps and water wheels occur to a considerable extent



Vulcan--Foettinger Speed Gear Applied to High-Speed Oil Engine.



Engine-room lay-out of German motorship with reduction gears and Foettinger hydraulic transformers.



Hydraulic Clutch Transmits no Torsional Oscillations. T_1, T_3, Critical and Normal Oscillations of Engine Shaft, T_2, T_4, Oscillations of Driven Shaft.

in those stationary members in which the transformation between pressure energy and velocity energy must be effected. Foettinger cleverly avoided these losses by never allowing the discharge from the centrifugal pump to slow down at all; he simply redirected the flow over the vanes and blading of the turbine which were so arranged as to give the desired ratios of angular velocity between the impeller and the rotor. Uncoupling of the driving unit as well as delicate speed control were effected by the extremely simple expedient of emptying the casings or of allowing the water to stand in them at suitable radial depths.

In the first applications of this arrangement relatively slow-speed Parsons turbines were used for driving the centrifugal pump, but modern turbines running at speeds exceeding 3000 r.p.m. are naturally out of the question when it comes to direct connection with a pump impeller. In order to satisfy the conditions necessary for satisfactory operation with a Foettinger transformer, the development of the present-day power-plant type of marine turbine would have had to be arrested; naturally this did not happen and the transformer was shelved instead.

The tendency to use high rotative speeds has of course made itself equally felt in the marine internal combustion engine field, as is shown by the increasing popularity of electric and geared drives; with the difference, however, that the "high speeds" here referred to are of an order of magnitude quite different from turbine speeds and are excellently adapted for centrifugal pump drives. Electric transmission is burdened with heavy installation costs, while gear drives by themselves according to some engineering minds have not as yet been completely freed from technical difficulties to enable widespread construction. The general state of affairs thus briefly outlined opens up a new breach into which the Foettinger roponents are apparently rushing. They offer a compromise solution in which the speed reducing function of the original device is partly surrendered to the gear-wheel principle and the hydraulic elements are reduced to a clutch. Whether or not the arrangement offers any advantages in point of cost by comparison with the electric or direct-gear drives is difficult to determine at present, but there can be but little doubt that it gives the same flexibility.

Resumes Vice Presidency

In order to resume the duties of vice-president and sales manager of the Atlas-Imperial Engine Co., Oakland, Calif., the well-known Pacific Coast oil-engine builders, Ralph Leo Van der Naillen has retired from active participation in the various mining interests with which he was lately affiliated, and will give his undivided attention to furthering the interest of marketing of Diesel engines.

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Palmers' 3,000 s.h.p. Opposed-Piston Diesel Engine

Single-Screw Unit for a 10,000 Tons Single-Screw Tanker, Constructed on the Fullagar Principle With Air Injection

NOT a very great amount of engineering attention has yet been paid in this country to the development of the Fullagar type of Diesel engine, although several of our shipbuilders have sent representatives to England to investigate its merits. The latter action unquestionably resulted through the limited amount of publicity occasionally given to the design in our pages. But the public is notorious for its short memory. Consequently the engine is not very well known in the United States. That the design, which radically differs from all others excepting the Doxford, must have certain advantages is indicated by the importance of the British and other European shipbuilders who have actively taken up its construction, and because one American firm of shipowners with British interests not long ago ordered three motorships with a total of twelve oil-engines of this type.

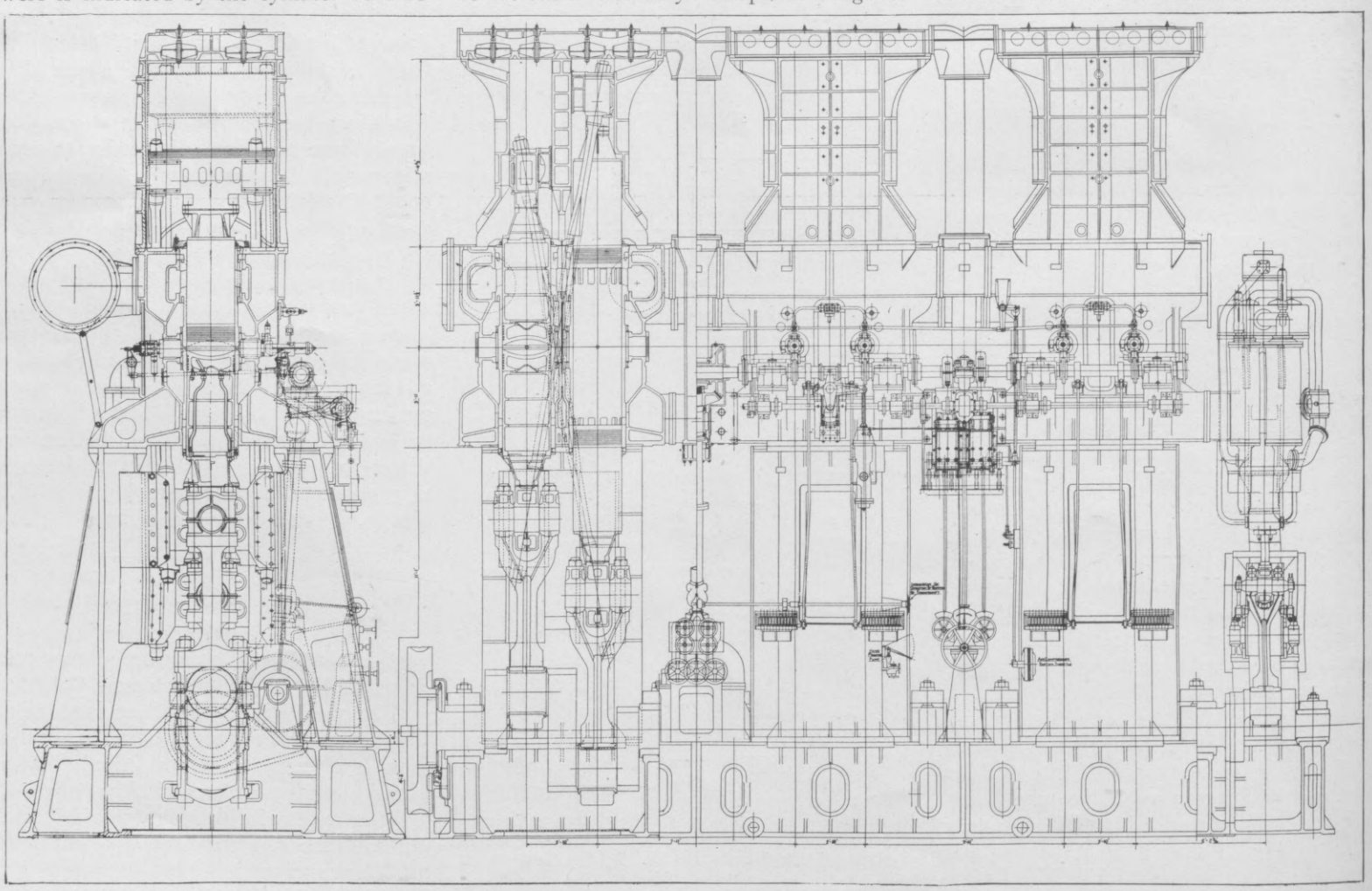
Considerable headway, however, has been made in Great Britain, and the greatest advance in the way of power has been shown by Palmers Shipbuilding and Iron Co., of Jarrow and Hebburn on the river Tyne, England, who have completed under Cammell Laird license the largest Fullagar Diesel yet commenced. It has an output of 3,000 s. h. p. at 90 r. p. m. from six opposed-piston cylinders 23″ diameter by twice 36″ stroke on the two-cycle principle. The possibilities of this design in high powers is indicated by the cylinder bore of 23 inches, especially as a single-acting two-cycle engine of similar cylinder dimensions and speed would only develop about 1,600 b. h. p. But, to be strictly fair, this design should only be compared with double-acting units. We make this comparison merely to indicate the power possibilities as there are single-acting two-cycle engines in service developing as high as 4,000 s. h. p. from six cylinders. A 33″ bore is probably within present day two-cycle safety limits, and this would give a Fullagar engine for moderate-sized Atlantic liners. The weaknesses of this type, if any, can hardly be found until at least a year from now, when some ships have had a thorough commercial test at sea.

This 3,000 b. h. p. Palmer-Fullagar unit is to be installed in a tank vessel of 10,000 tons deadweight, now under construction at the firm's yard.

The main features of the Fullagar design is familiar to many of our readers, and the engine which we illustrate in this issue embodies all the latest improvements which have been evolved as a result of experience. The six-cylinders are disposed in three units, and so arranged that any one unit can be cut out if necessary. A special design of cylinder liner of cast-iron is fitted, and made of moderate thickness throughout, while the portion subjected to the greatest heat and pressure *is reinforced by steel bands.* At the same time provision is made for an ample circulation of cooling water, which passes through spaces between the cast-iron liners and the outer bands. The cylinder-jacket cylinders are made of ordinary cast-iron as these parts do not take any of the working loads of the engine.

Cast steel is extensively used in the moving parts, the upper and lower crossheads, piston heads and top and bottom end bushes being of this material. The piston heads are secured to cast-iron skirts and cast-steel distance pieces connect these to the crossheads, piston rods being eliminated. Spur and bevel gears are used for driving the camshaft on which two sets of cams are provided, the camshaft being moved longitudinally when reversing the engines.

With a view to economy in the use of high-pressure air for maneuvering mechanical operation of starting valves, etc. has been adopted, but the servo-motor for sliding the camshaft is operated by air of 600 lbs. pressure. Starting and maneuvering operations of the engine are all controlled by the motion of one handwheel at the starting platform. The engine is brought to a stop, reversed, started on air and followed up on fuel by the operations performed due to the motion of this handwheel. Two other handwheels on the same



The three-cylinder 23″ by twice 36″ opposed-piston type Palmer-Fullagar Diesel engine of 3,000 s.h.p. for a 10,000 tons tank motorship.

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oil engine, which uses airless-injection of fuel, the Palmer-Fullagar design incorporates the use of injection air so is of the true Diesel type.

A four-stage compressor is provided for injection air, each compressor cylinder being fitted with removable liners. The general practice in the United States is three stages.

Fresh water is used for engine piston and jacket cooling, and coolers are placed in the system, on the outlet pipes, so that the water is coolest when being returned to the double bottom storage tank. *Arrangements are being made to raise steam by means of the exhaust-gases for heating and cooking purposes.*

Simplicity, ease of accessibility for overhaul and small space occupied are among the claimed advantages of this type of engine, as is also the absence of cylinder heads. It can be compared very favorably with other types in its weight per horsepower. An outstanding feature is the high degree of balance obtained, which relieves the engine seating from vibration, and as the piston loads are balanced in this opposed-piston engine, the engine framing is free from direct stresses.

Large scavenge-air ports are available consequently the air pressure for low-speed engines is only about 1 to 1.5 lbs. per sq. in. It has been found that the engine is very suitable for burning low grades of fuel. With ordinary fuel oil, consumptions are low as 0.39 lb. per b. h. p. per hour have been obtained. On account of the good balance of the engine, its properties when maneuvering can be appreciated, since a smaller example of this type of engine has been run without misfiring at the remarkably low speed of 16½ revolutions per minute.

How the World's Largest Diesel was Built

Special Story Relating How the Problems of Constructing a Marine Engine Which Developed Over 17,000 Shaft H. P. Were Overcome

By F. ENGLERT.

PART III

(*Continued from Page* 41, *Jan.*)

I WILL not explain, in detail, the development of the heads or of the piston. It was a long sequence of harassing troubles, and all attempts to overcome them by changes of design and the use of cast-steel were failures for a long time.

The final outcome was that the lower head was made of grey iron fitted with ribs which nearly touched the hot face and which forced the cooling water to rush along it with great velocity; the upper head was also made of grey iron but with a double bottom and spiral ribs, provided for the same purpose of increasing the heat exchange by forcing the cooling water to move over the surface very rapidly. To maintain a cooling system at high efficiency, it is necessary to keep the cooling surfaces free from scale or other deposits. So it was decided to cool the pistons, shield rings and upper heads with pure distilled water. All other parts were cooled by sea water. The results of these changes may be estimated from the figures of the following tabulation:

	Circulating water Gall. per min.	Heat carried away B.T.U. per hr.
Test No. 1 1830 *B. H. P.*		
Upper Head	72.9	361,000
Upper Shield-Ring	77.9	4,570,000
Lower Shield-Ring	32.8	4,570,000
Piston	64.7	9,340,000
Test No. II 2110 *B. H. P.*		
Upper Head	74.7	337,000
Upper Shield-Ring	79.0	4,980,000
Lower Shield-Ring	33.3	5,420,000
Piston	59.4	11,250,000

The overwhelming importance of the shield-rings is at once apparent. In both instances the material of the upper ring was grey iron, that of the lower one cast steel.

The trials with this cylinder were concluded by a continuous run of 5 days, the load being 2,120 b.h.p., the speed 127 r.p.m. An inspection after the test showed that the new lower part (see page 41 and fig. 7, December installment) was free from cracks and that in the upper part new cracks had not developed.

But again a new trouble had made its appearance. Corrosions were found on that part of the cylinder wall covered by the shield-ring and also on the back of the ring itself. The reason for them was traced to the fuel oil which orignally was standard Diesel oil, but later tar oil. The fuel valves had been designed to use tar oil and the engine had been run for quite a while, and especially during the 5-day trial, on this fuel which contains an appreciable amount of sulphur. The sulphurous, and eventually sulphuric, acid which are formed during and after the combustion of this element condensed on the cold walls of cooling ring and cylinder either during the operation of the engine, or after stopping it, and corroded their faces. There is also a chance that galvanic actions may have taken place. These corrosions were easily overcome by spraying the walls with tin and lead with the well known Schoop Sprayer.

After the successful termination of this series of experiments a new upper part (shown in fig. 8) was built on the lines of the lower one and the two parts together subjected to a run of 500 hours at 2,100 b.h.p. An examination of the cylinder parts which now had run between 513 and 1,345 hours showed them to be in splendid condition. In order to play safe, an entirely new cylinder was now built which corresponded exactly to the last one, and this with the original parts of the rest of the engine was subjected to a trial of 503 hours' duration at full load. This was done in order to determine whether the ability to stand up was intrinsically inherent to the design. The inspection after the trial showed very satisfactory results. Some of the parts had already stood up during 1,590 to 2,575 hours of operation.

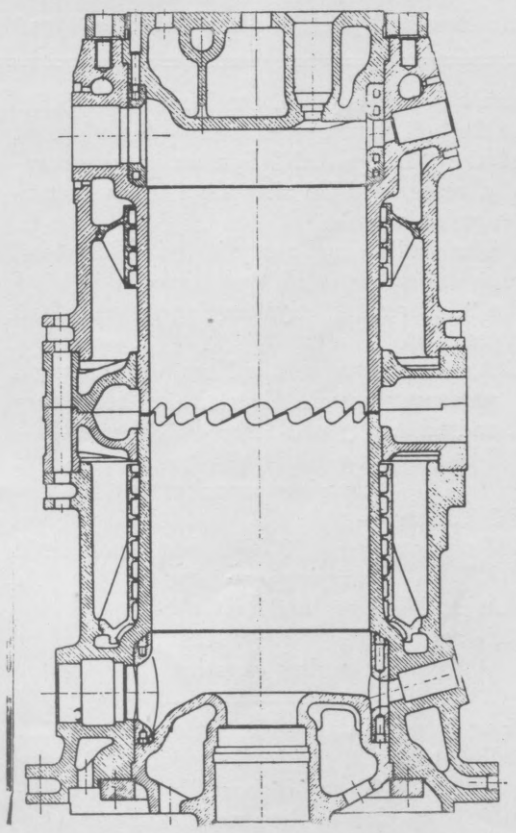

Fig. 8— Test cylinder showing final development of shield-rings, valve chambers, and head.

Thus it was proved to our satisfaction that the problem of the double-acting 2,000 b.h.p. two-cycle cylinder had finally been solved.

After the termination of these experiments a 12,000 b.h.p. six-cylinder engine was designed, built, and subjected to a series of exceedingly exacting trials. Before reporting about them the results obtained with the experimental cylinder during further trials may be outlined.

These were undertaken with the intention of finding out the maximum load which could be carried. Two factors were considered as decisive in this connection: the structural safety of the engine parts and the minimum excess air factor. Obviously it was preferable to have the load limited by scarcity of combustion air so that the engine could not be damaged by an occasional overload. After some preliminary trials during which a load of 3,315 i.h.p., corresponding to 129.0 lbs. m.i.p., was maintained during 6 hours (at 90.3% mechanical efficiency of the engine, all pumps electrically driven), a final run was undertaken during which the load was increased to 3,525 i.h.p. corresponding to 137.6 lbs. m.i.p. The mechanical efficiency was 90½. The fuel consumption curve illustrated in Fig. 9 shows that actually the quantity of combustion air in the engine limited the maximum load. The cylinder was then taken down and no fault found. It was set up again and ran for months without

(*To be concluded next month*)

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Machinery of "Motor-Steamer" Dolius

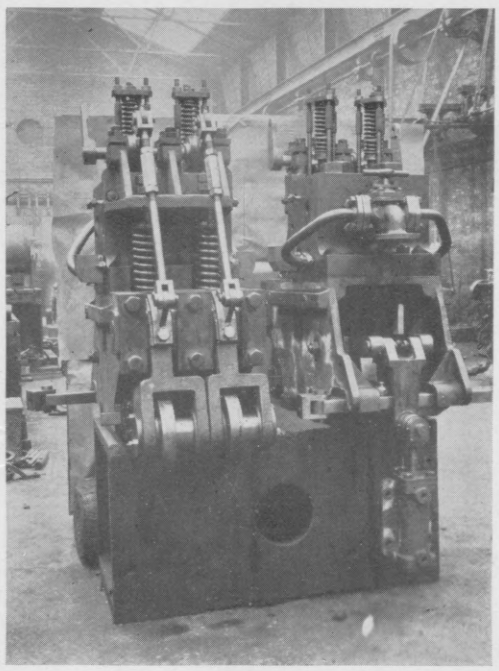
Continuation From Page 33 January Issue of the Description of the Two 1250 Shaft h. p. Scott-Still Combination Steam and Diesel Engines

PART II

ADEQUATE lubrication is provided for the piston by means of a circumferential oil-groove above the scavenge ports and another groove at the same respective distance above the exhaust ports. These two grooves extend around the circumference sufficiently to give a certain amount of overlap, and each is supplied with oil at two points. Forced-feed lubrication is used for cross-head pin bearings, the crank-pin bearings and cross-head guides.

Fuel is mechanically injected by means of an automatically controlled system. Combustion takes place partially at constant volume, partially at constant pressure (known as the mixed cycle), the fuel being admitted only very slightly before the top centre. The hot jackets of the Still cylinder make it possible to secure positive ignition of the fuel with a compression pressure of only about 350 lb. per sq. in. resulting in a maximum cylinder-pressure of about 550 lbs. per sq. in., which is usual with this type of injection.

The oil-fuel pumps, shown in one of our views, are located on the engine bed, one body with two separate pumps being situated on each side of the crankshaft. A pressure of 5,000 lb. per sq. in. is used (plungers have 1¼" dia.) to lift the spring loaded automatic fuel-valve at the correct firing point. Firing will always commence at the same point in the cylinder cycle as the time of pump delivery is fixed, but by opening a spill-valve (hand controlled and coupled to governor for limiting maximum speed and to prevent racing) the amount of fuel passing into the cylinder is regulated. With



Scott-Still fuel-pumps.

the opening of the spill-valve the fuel pressure drops and by timing the spill-valve early or late the amount of fuel injected will vary and with it the power delivered by the engine. The moving parts of such a valve gear are very light, hence the opening and closing speeds are higher than can be obtained with cam operated valves.

On the crankshaft centre coupling are mounted the four sets of ahead and astern cams operating the fuel pump rockers through cam rollers, which slide horizontally to engage with the correct cams. The scavenging air for both engines is supplied by a Brown-Boveri turbo-blower (speed about 3,000 revs. per min.) which is operated by steam at about 24" vacuum after same has passed through the main engines on its way to the condenser which is maintained at 27 or 28 in. vacuum. An alternative method (a standby in case the exhause-turbine breaks downs or the vacuum is low or insufficient exhaust steam is available) is provided by an electric motor coupled to the blower shaft.

If more than sufficient steam is available, the turbine will drive the electric motor as a dynamo, which is then cut into the switchboard. The scavenge air on its way to the cylinders is taken into the bedplate of the engine and then passes through the hollow A frame to the scavenging belt around the cylinders. The steam-cylinder liner is closed at the bottom with a cover of deep formation, extending upwards around the piston rod, only a small annular space being left between this formation and liner for the piston skirt, in order to keep the clearance volume as small as possible. Steam is admitted to and exhausted from the engine cylinders by piston valves, three of which are located in each cover.

An electrically driven variable delivery pump supplies lubricating oil under a pressure of 400 lb. per sq. in., through a distributor, to pipes leading to the admission and exhaust piston valves (3½ in. dia.) and also to the gear for reversing the direction of the engine.

(To be concluded next month)

The Isherwood System of Ship Construction

In connection with the survey of shipbuilding operations for the present year, it is intresting to note that the Isherwood System has secured its share of the new contracts that have been placed. From Sept. 1907 to Dec. 1908 when the Isherwood system of hull construction was first produced, only six vessels, totalling 31,608 tons d. w. c. were built, compared with 1,443 vessels aggregating 12,174,490 tons in service and building at the end of 1923. This remarkable growth denotes the value of the system, and accounts for so many modern motorships being Isherwood type.

Two of the contracts placed last year are for 12,600 tons dw. motor tankers for the Standard Oil Company of New York. Another is for a 12,800 ton motor tanker to be built at the Nakskov Shipyard, Nakskov, Denmark. An interesting feature of this latter contract is the fact that the vessel will be the largest built in Scandinavia.

All three vessels, as previously recorded in MOTORSHIP, are to be fitted with twin-screw Diesel engines, the increased rigidity of the hull structure secured by the adoption of the "Isherwood" System being generally recognized as advantageous in motor-propelled vessels.

The following analysis of Isherwood type ships exemplifies the adaptability of the "Isherwood" System for vessels of all types:

General cargo-vessels, colliers, ore steamers, passenger vessels, Great Lakes freighters and passenger and ferry freight vessels—
647 aggregating 5,794,430 tons deadweight carrying capacity.

Oil Tankers—
664 aggregating 6,306,690 tons deadweight carrying capacity.

Barges, Dredgers and trawlers—
132 aggregating 73,370 tons deadweight carrying capacity.

New President for N. Y. Dry Dock Co.

Following the resignation of G. C. Clarke of the New York Harbor Dry Dock Company, Inc., due to the pressing demands of his other business interests, D. V. Stratton has been elected as President in his stead. Mr. Stratton has had an extensive experience in marine construction and repair work.

After the great ship construction period, Mr. Stratton went to Europe to assist J. E. Sheedy, Vice-President of the Shipping Board in the reorganization of the forces of the Shipping Board in Europe. During this time Mr. Stratton made an exhaustive study of the problem of ship maintenance and operation in the various European shipping countries. He visited all of the principal building and repair plants of Europe with a view to comparing from the standpoint of equipment, organization and control methods with the plants of the United States. The futuer tendencies in ship design and construction, particularly with reference to Diesel drive, were made a special and careful study. Upon his return to the United States he entered the organization of the Morse Drydock & Repair Company in charge of business development. After two years with the Morse plant Mr. Stratton resigned to take up his present position.

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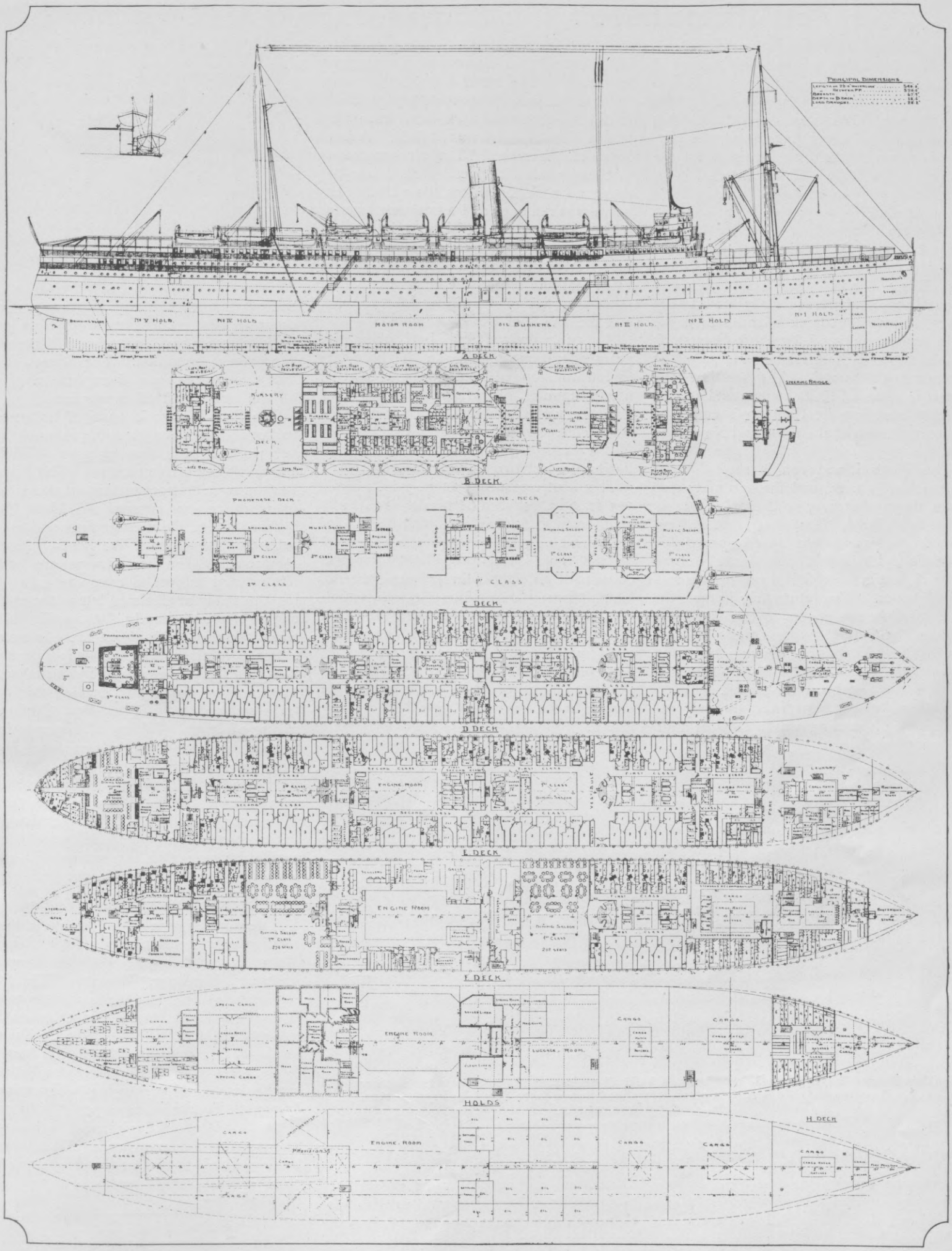

Profile and general arrangement drawings of the combination passenger-cargo motor liner just ordered by the Netherlands Steamship Co., Amsterdam, Holland, from the Loire Shipbuilding Co., St. Nazaire, France. She is 14,000 gross tons register and will be driven by twin Sulzer 8-cylinder, 2-cycle type Diesel engine aggregating 8,000 shaft h.p. Much furore has arisen in Holland through the order having gone to France, which matter is discussed on the Editorial page of this issue. In addition to the main engines there will be three Diesel-driven 325 k.w. D.C. auxiliary generating-sets. The vessel will carry 528 first and second-class passengers, 57 third and 54 fourth-class passengers. Length 540 ft. The contract price is 4,900,000 guilders, or $1,862,000. The lowest Dutch bid was 6,200,000 guilders.

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Schedule Maintained for Two Seasons

Contrary to the claim of steam enthusiasts that the Diesel engine's only source of recognition is its remarkable fuel economy, the reliability factor is rapidly coming into prominence. Disregarding the economy, which is today never questioned, the passenger boat NELSECO II furnishes an example of the ability of the internal combustion engine to maintain practically a train schedule.

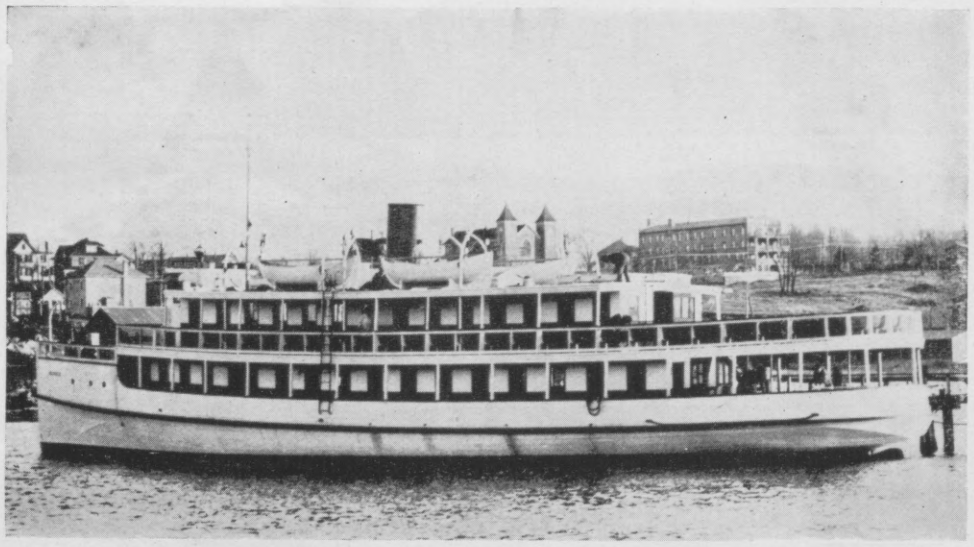
This craft, owned by the New London Ship & Engine Co., is chartered each summer for operation between Norwich, Conn., and Block Island. She starts this run about July 1 and closes shortly after Labor Day. Before the Block Island season she is in popular demand for short excursions to Fisher's and Plum Islands and points of interest in the Sound. At other times the vessel is returned to its owners and acts as a ferry boat for the Company's employes between the works at Groton and New London.

The Block Island run is started from Norwich at 9 a. m., and the trip of twelve miles down the river to New London is made in an hour. Trains are met at New London and passengers taken aboard for Block Island, which is approximately thirty miles distant and requires a run of two and a half hours. The return trip is made in time to allow passengers to catch at New London the through express trains to Boston and New York. For two months of the summer the round trip of about ninety-five miles is made seven days a week.

During the season of 1922, the only interruption of running was a stop of four minutes, occasioned by a leaky valve, which was removed and replaced by a new one in this time. The summer of 1923 passed without incident, except for delays of eleven minutes, also caused by a valve, but in this instance the material was at fault. A small piece of the second stage air compressor discharge valve chipped off and dropped down on a screen below the valve. The valve was removed and a new one inserted in the short space of seven minutes, the chip, however, being overlooked. A day or so later, the chip lodged itself on the valve seat and scored the new valve. Another stop was made, lasting four minutes, and the source of trouble eliminated.

Summing up, we find that during two years operation on this run the boat was forced to stop en route only a total of fifteen minutes. Furthermore, after each stop the lost time was made up and the train connections made at New London. Not a single trip or schedule was missed during the last two summer seasons.

This boat measures 122 ft. 7 in. overall, 115 ft. 0 in. between perpendiculars, 28 ft. 9 in. beam, 9 ft. 6 in. moulded depth, and on a draft of 5 ft. 8 in. has a displacement of 188 tons. Her propelling equipment consists of an eight-cylinder four-cycle 240 b.h.p. directly reversible Nelseco engine turning at 350 r.p.m. and driving the vessel at 10½ knots. A reverse clutch was originally installed, but last spring the engine was changed to direct reversing. The conversion eliminates a possible source of trouble in the clutch and gives better power astern.



This Nelseco Diesel-powered ferry helps to build oil-engines, as she transports the workers at the New London Ship & Engine plant across the Thames from New London to Groton, Conn., during winter months

Motor Tug "Say When" Saves $14 a Day

For some years a steam-driven service-launch and tug has been in the employ of the Morse Dry Dock Co., of Brooklyn, N. Y., namely, the SAY WHEN, a 60-footer, propelled by 250 b.h.p. triple-expansion steam machinery. Continuous hard service made it necessary to recondition this craft, so her owners decided to remove the steam plant and install a Fairbanks-Morse oil-engine. It was found that the very wide difference between the ratios of continuously available horsepower to rated horsepower in the steam engine and the oil-engine would enable the oil-engine to be of much less rated horsepower than the old steam job. A 100 h.p. oil-engine was selected and the hull was reconditioned through. The complete conversion, including new machinery, rebuilding deck house, installation of new tanks and general overhaul of hull cost $10,712.47. Very accurate cost records were kept on past performances, as is now being done with her present operation. The figures show that the savings in a short time will pay off the entire cost of conversion.

The "Say When"

The SAY WHEN is engaged in general harbor and yard work six days a week, and her work is such that extreme reliability and flexibility are imperative. She is used for towing, for transporting workmen and many other jobs around the New York harbor district, the average time under way each day being about five hours. As the requirements for her service are intermittent and subject to telephone calls, she must be ready at all times, but as the engine can be started instantly, the standby losses when operated with steam are eliminated. When a steamer her total daily operating cost was $11.41 per day. The installation of oil-engine power has enabled this cost to be reduced to $5.44 per day, effecting a saving of $5.97. Taking all expenses into account, over equal periods of time, averaging five hours per day underway, the total cost per hour in commission was $3.25 as a steamer and is $1.56 as a motor-boat. This means a saving of $13.76 per day due to the change to oil-engine drive and it can readily be seen that this saving will soon pay off the cost of the change.

German Rotary Diesel Engine

A new rotary-type Diesel engine in three rotating cylinders has been built by Michel Motor Lizenz & Baugesellschaft, Kreusler strasse 4, Hamburg, Germany. The first engine has been completed and ran tests. It is of 120 h.p. at 110 to 120 r.p.m. on the two-cycle system. There are no cylinder-heads as the combustion chamber is formed by the apex of the three inverted cylinders, air admission and scavenging being entirely by ports. Transmission of power is by piston-rods direct through roller crosshead beams on to a curved track. This curved track is fitted on the inside of an enclosed rotating part, which revolves around the fixed cylinder.

Motor Meat Carriers

Wm. Beardmore, Ltd., Dalmuir, Scotland, will build two of the 16 frozen meat carrying motorships for the Kings Sound, Western Australia-London seervice, and bids are being asked on the others. Government support will be given to the project.

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Steamer "Lake Weir" Converted to Motor Dredger

Interesting Installation of Two Worthington Oil Engines

During the present year the first commercial, privately-owned Diesel electric hopper dredge will be put into service on the Great Lakes by the Construction Materials Company of Chicago. This is the ex-lake type steamer LAKE WEIR recently purchased from the Shipping Board under the conversion guarantee. The new owners will use the vessel for dredging, and for transporting construction materials for building purposes.

The Worthington Pump & Machinery Corp. have received the order for the oil-engines, while contract for the electric equipment has been placed with the General Electric Company. The propelling machinery consists of two 600 shaft h.p. oil-engines, each direct connected to a 400 k.w. main generator and a 35 k.w. auxiliary generator. Under normal operating conditions, each main generator will drive a 500 horsepower motor direct-connected to a propeller, the craft being of a twin-screw type. Ward-Leonard control will be used, providing independent control of each propelling motor and arranged for operation from either the pilot house or engine-room. Provision will also be made for operating both propelling motors from one generator.

One auxiliary generator will furnish excitation for the motors and generators and the other will be used for furnishing power for driving the engine-room auxiliary motors, steering-gear and lighting. All the auxiliaries will be electrically driven.

In addition to the propelling equipment, there will be provided two 400 horsepower, G. E. motor-driven dredging pumps. The power for these will be taken from either or both of the main generators. Under one condition of operation, both dredging pumps will be driven from one generator, the other generator furnishing power for propulsion. Under another condition of operation, when no propulsion is required, each dredging pump will be connected to a main generator and will operate independently.

The LAKE WEIR measures 261 ft. in length, with a beam of 42½ ft. and a draft, when loaded, of 18 ft. Included among the auxiliaries, besides the steering gear, will be two 10 h.p. pumps and six smaller pumps. The dredge will also be equipped with facilities for handling dry material.

Norden S.S. Company Accept Their First Motorship

Nordbo, a New Burmeister & Wain Production of 8,250 Tons d.w.

Another unit on the long list of Motorships built and engined by Burmeister & Wain, Copenhagen, was added on the 15th November, in the new Diesel powered ship "NORDBO," which has just completed her trials and been handed over to her owners, the "NORDBO" Steamship Company, Copenhagen. It is their first motorship.

The "NORDBO" has been built to the highest class of Lloyd's Register 100 A.1.X., and her principal dimensions are:

Type of ship	Shelter deck
Length between p.	380′ 0″
Breadth moulded	53′ 6″
Depth	36′ 0″
Draught loaded	25′ 0″
Deadweight capacity	8,250 tons
Register gross tonnage	4,465 tons
Capacity of the holds	435,400 cu. ft. bales
Stipulated normal average speed at sea	10.5 knots
Fuel consumption net 24 hours	8.5 tons

The particulars of the machinery are:

Type of machinery	2 Burmeister and Wain's 6-cycl. 4-cycle short stroke Marine Diesel engines
Cylinder diameter	590 m/m.
Stroke	900 m/m.
Revolutions per minute	130
Indicated h. p.	2,600

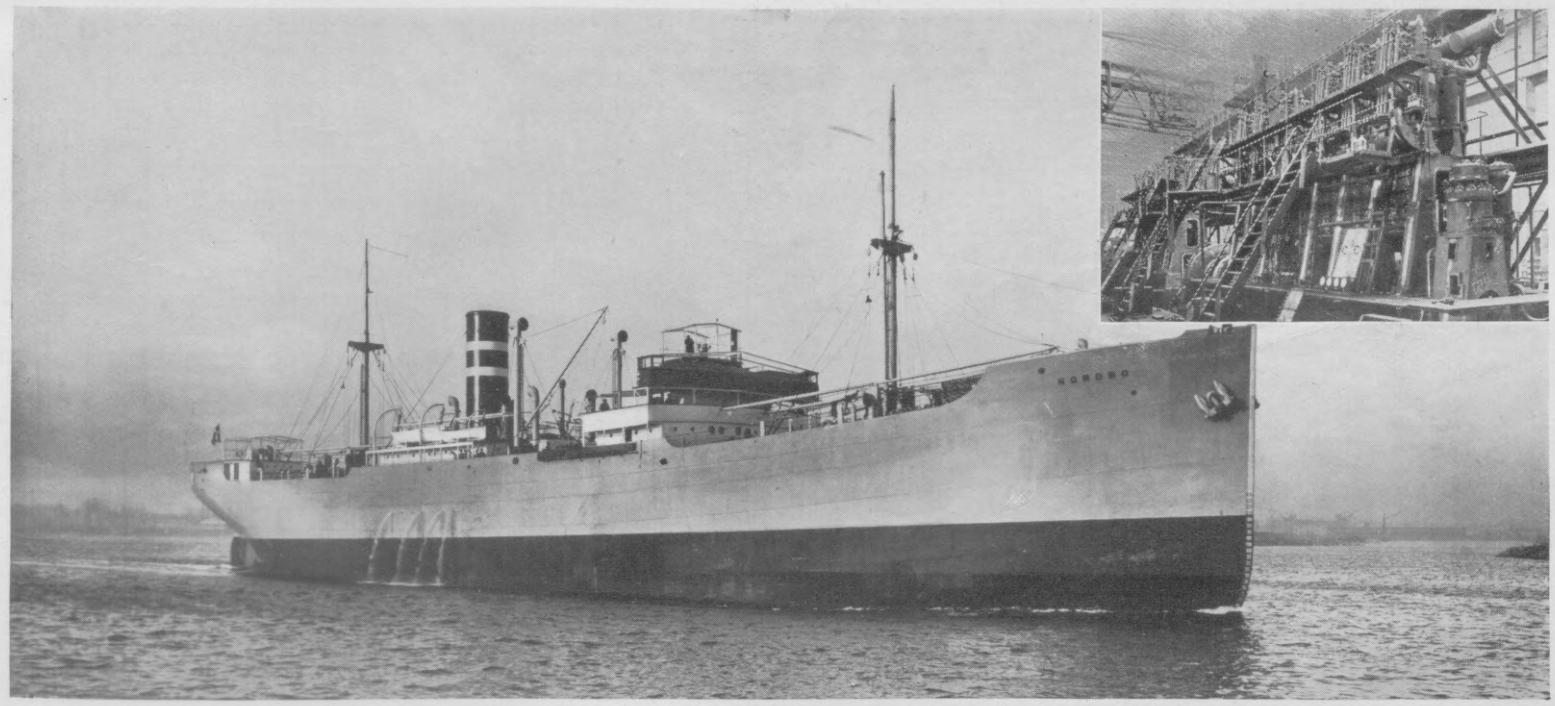
The trial results (average of four runs) from trial trip in the Sound, November 15, 1923, were:

Draught average	8′ 8¼″
Indicated h. p. average	2,986
Revolutions per minute average	154.6
Speed average	11.65 knots

During the consumption test the main engines developed 2,940 i.h.p. at 153.7 revolutions per minute, on a fuel oil consumption of 142.5 grammes per i.h.p. hour, lower heating value being 10,069 kg.cal (18,100 B.T.U.). All auxiliary machinery is electrically driven, following Burmeister & Wain's usual practice.

Yet Another Big Motor-Liner

To the list of large motor-vessels now under construction in Europe as given on page 9, of our January number, should be added a new motor-liner just ordered by the Netherlands Steamship Co., of Amsterdam, from the Societé Anonyme Chantiers Loire, of Saint Nazaire. This vessel is of 21,200 tons displacement and 14,000 tons gross. She will be propelled by two Sulzer, two-cycle type Diesel engines of 4,000 shaft h.p. each. Both have eight cylinders, 680 mm. diameter (26.77 in.) by 1,200 mm. (47.24 in.) stroke, turning at 100 r.p.m. In each vessel there also will be three Sulzer auxiliary engines of 520 b.h.p. The length over all of the ship is 540 ft. by 67.9 beam.



New twin-crew motorship Nordbo of 8,250 tons just taken over by the Norden Steamship Co. of Copenhagen. She is a Burmeister & Wain production and is propelled by the twin 1300 i. h. p. B. & W. Diesels shown in the insert.

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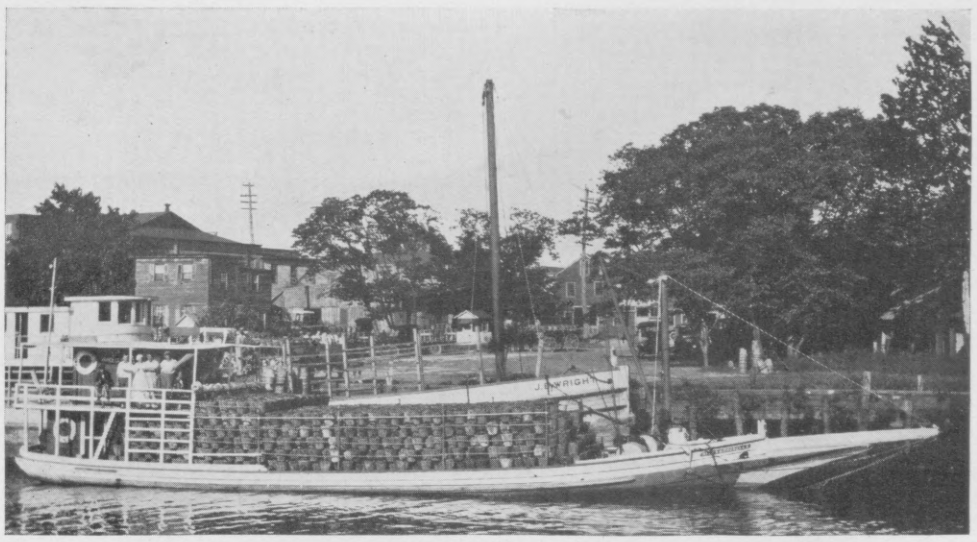

Loaded with a big deck cargo the Wolverine oil-engined coastwise boat "Helen & Rhodella" ran into a bad storm, but pulled through successfully.

Facing Heavy Odds

In a letter written recently by Capt. Edward Gaskill, owner of the HELEN & RHODELLA, a 70 ft. by 21 ft. coasting boat equipped with a 70 h.p. Wolverine oil-engine, remarkable testimony is furnished to the present day reliability of marine oil-engines. HELEN & RHODELLA, heavily laden and with a big deck cargo, ran into a gale off the Jersey coast. The big seas strained her and caused her to leak badly. The bilge pump on the main engine was unable to keep the water down, and the auxiliary bilge pump, which throws a 2-in. stream of water and is driven by a gasoline engine, was started. After a time this auxiliary gave out, and recourse was made to a hand pump. The water gained until it reached about 5 inches up the flywheel, which meant, with the main engine running, that water was flying all around the engine-room. There is no doubt that in such a case gasoline engines would have been stalled. The oil-engine, however, kept going in this way for nearly five hours until the boat made port.

British Columbian Oil-Engined Boats

"COLUMBIA," a vessel 100 feet o.a. by 17 foot beam, operated by the Columbia Coast Mission in the mission to loggers and as a hospital tender on both the east and west coasts of Vancouver Island, is being equipped with a six-cylinder Atlas-Imperial Diesel engine of 8½" bore by 12" stroke, developing 140 b.h.p. at 325 r.p.m. The auxiliary engine is an Atlas-Imperial 4 h.p. gas engine and compressor combined. There is a separate auxiliary engine running a generator for light, and power for the windlass. The COLUMBIA was among the earliest vessels on the British Columbia coast to adopt oil-engine power. About 9 years ago a 100 h.p. four-cylinder Campbell (British) surface-ignition engine was installed in place of a gasolene engine. She could make about 10 knots with this power, her ordinary cruising speed being 9 knots. With the new 140 h.p. Diesel it is expected that she will be able to cruise at better than 10 knots. The new engine is being installed at Vancouver, having been secured through Ferrier & Lucas.

The small coast freighter ECHO III, of Vancouver, B. C., has been equipped with a 55 h.p. two-cylinder Kahlenberg surface-ignition oil-engine driving a single propeller of 42" diameter and 32" pitch at 340 r.p.m. The cylinder bore is 10" and stroke 10½". This engine replaces a twin-screw installation of two single-cylinder 20 h. p. surface-ignition engines.

New Haven oyster boat "Mildred" equipped with a 46 b.h.p. Wolverine oil-engine. She carries about 750 bushels

OUR READERS' OPINION

Yet Another Convert

To the Editor of MOTORSHIP:

We have received three copies of your publication and wish to thank you for them. While we are getting along in years and business is not what it used to be in our vicinity, we want to assure you that if we continue in this work much longer, we are sure to adopt the motor engine for our work. We are enclosing check for MOTORSHIP. A. J. TAYLOR & BRO.

Tow-Boat Owners & Ship Chandlers,
10th. & Water Sts., S. W.,
Washington, D. C.

Just Like Billy Sunday

To the Editor of MOTORSHIP:

In some ways your magazine and its methods remind me of Billy Sunday and his fervent religious campaigns, but is successful in its results for the reason that what you have to say is based on solid foundation and evidently backed up by sincerity. You hammer and hammer and hammer until your words thoroughly sink in. One by one the ardent steam veterans are being converted to the sound idea of economical oil-engine power. Be just like Billy Sunday, don't let anything deter you, but just keep on pounding, pounding, pounding.

ONE WHOM YOU CONVERTED.

San Francisco, Calif.

Our Coastguard Service and the Oil Engine

To the Editor of MOTORSHIP:

We have followed with much interest the development and application of oil-engines for marine propulsion, and are quite convinced of the great desirability of using them, especially where they can be used in conjunction with electric drive, this being the only possibility of their use in Coast Guard vessels. Q. B. NEWMAN,
Engineer-in-Chief.

Treasury Dept.,
U. S. Coast Guard,
Washington, D. C.

Copies of October 1923 Wanted

To the Editor of MOTORSHIP:

I wish twelve copies of the October issue of MOTORSHIP. Myself and practically all the crew of the motorship TWIN PORTS are desirous of getting this number, especially as it is of so much interest. I have seen the October number, but have been unable to buy a copy. Will you kindly hold or mail twelve copies of this issue? It will be greatly appreciated by us all. We will be in New York shortly. JOHN D. NOBLE.

Engineer,
M. S. TWIN PORTS,
Minnesota-Atlantic Transit Co.,
% M. H. Tracy & Co.,
17 State St., New York.

(Recently we bought back some October copies and now have a few on hand.—Editor.)

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Interesting Notes and News

The motorship SEEKONK recently converted by Cramps has arrived in New York following her maiden voyage.

Trials of the big North British double-acting Diesel engine will shortly be carried out by the British Marine Oil Engine Trials Committee.

WAJANG will not be the name of the new motor-liner now being built for the Rotterdam Lloyd. This has been changed to INDRA POERA.

Special Diesel engine works are to be erected by the Akers Mek. Verksted, who have been building Burmeister & Wain Diesel engines at their shipyard.

Two more 600 shaft h. p. airless-injection marine oil-engines have been ordered from Vickers, Ltd., by the Mitsubishi Shoji Kaisha, making a total of four.

Diesel oil is being sold for $1.65 to $2 per barrel at Balboa by the Panama Canal. At Cristobal the canal's price is $2.35, so motorships should bunker at Balboa.

A Diesel-driven tanker of 6,500 tons d.w. is building at the yard of the Fijenoord Shipbuilding Co., Rotterdam, who are constructing Diesel engines under Augsburg license.

WESTERFELD the 14,000 tons geared-Diesel driven motorship building for the Hamburg-South American Line by Blohm & Voss, will shortly be described in this magazine.

A motor-auxiliary named GUSTAV STEIN, of 700 tons d.w. was recently placed in service in Germany by the Reederei J. H. Jensen Nachf. A 350 shaft h.p. Benz oil-engine is installed.

Another of the Bank Line motorship fleet, the single-screw 4,320 gross tons freighter LUXMI, was launched on January 19th. A Harland-B. & W. Diesel engine is installed. Dimensions of ship, 384′x48′ x36′.

A friendly arrangement has been entered into by the Reiherstieg Shipyard, Hamburg, with the Mannheim Motor Works, builders of the Benz Diesel engine.

Prince Yousouf Kamal's 800 tons motor-yacht NAZPERNER was launched last December at Ramage & Ferguson's, Leith yard. She is propelled by twin 850 shaft h.p. Sulzer Diesel engines.

Orders for Diesel engines will be placed in Germany for the conversion of the Japanese 13,000 tons gross steamships TENYO MARU and SHINYO MARU owned by the Toyo Kisen Kaisha.

Among the motorships building at Harland & Wolff's Queen's Island Yard is one of 14,000 tons d.w.c. for the Glen Line of London. Twin 3,200 i.h.p. Harland-B. & W. Diesels are being installed.

Seventeen motorships aggregating 82,323 tons net register passed through the Panama Canal during last November, and paid $79,165.33 tolls. Six motorschooners also went through the canal.

Twin 1,500 h.p. Krupp Diesels are installed in the 9,000 tons mailmotorship RIO BRAVO, launched on January 5th by Krupps, Kiel, for the Hamburg Ocean Line. Dimensions, 394′x52½′ x24½′. Speed, 13 knots.

The San Rocco Shipyard, Muggia, near Trieste, expect to lay down a 11,000 tons d.w. motorship, somewhat similar in design to the British motorship DORSETSHIRE, illustrated in our issue of October, 1920.

To make a complete study of the European Diesel engine situation as well as to study European oil-firing systems for boilers, J. S. Milne, chief engineer of the Todds Shipyards Corp. recently sailed on the S.S. AMERICA.

The 550 shaft h.p. crosshead type Pacific-Werkspoor Diesel engine will be installed in C. D. Mallory & Co's vessel PINTHIS, by the Newport News Shipbuilding & Dry Dock Co., who are carrying out the construction work.

The first two sets of Diesel engines, built by the North Eastern Marine Engineering Co., under the Werkspoor license, have now completed very satisfactory trials in the shops. They are for Hunting & Son's new 7,000 tons tank. motorship WELLFIELD.

The third engine to be tested by the British Marine Oil Engine Trials Committee will be the Hawthorn-Leslie-Werkspoor marine unit of the four-cycle type developing 1,400 i.h.p. from six cylinders 560 mm. (22.04 in.) bore by 1,000 mm. (39.37 in.) stroke, at 125 r.p.m.

There are approximately 1,250,000 d.w. tons of Diesel engines and motorships now on order in various parts of the world. We refer to vessels of over 500 tons d.w., apart from the thousands of smaller commercial and pleasure motor craft also equipped with oil-engines.

The largest airless-injection oil-engine yet constructed is the Vickers, four-cycle type Diesel of 3,000 shaft h.p. completing for the Donaldson line cattle vessel. It will develop its normal power at 110 r.p.m. from eight cylinders 30 in. bore by 45 in. stroke.

Lithgow's Ltd. of Port Glasgow, are building a 12,000 tons, 6,000 shaft h.p. vessel for the Union Steamship Co. of New Zealand, for meat cargoes and general cargo service between Great Britain and Australia. Twin 3,000 shaft h.p. Sulzer Diesel engines are being installed.

The first Diesel engines constructed at the Belfast plant of Harland & Wolff were the two recently installed in the Royal Mail Line motorship LOCHMONAR. Previously Harland-B. & W. Diesel engines have been built at their plant at Glasgow. The large double-acting Diesel engines for the Royal Mail and Union Castle Lines will be built at Belfast.

In 1922 Denmark had 790 motor vessels aggregating 181,496 tons gross register. In 1923 this was increased by fifty motorships, bringing the total to 211,204 tons. During the same period Danish steamshipping was reduced from 790,144 tons to 773,742 tons. Motorships now comprise nearly one-third of the total Danish merchant marine.

Norwegian motorshipping increased by 22,841 tons gross register during 1923; but Norwegian steamshipping was reduced by 722,841 tons. There are now 165,000 tons of large Norwegian-owned motorships in service, many having been built in other countries. As mentioned in January, they earned a profit of Kr. 30,000,000 for their owners.

The steamer J. J. SISTER, which is now being converted to Augsburg submarine type Diesel engine power at the Fijenoord Shipyard, Rotterdam, will have direct connected engines. There will be no reduction gear transmission, as previously reported. She is to the order of the De Maas Steamship Company, and her name will be KATENDRECHT.

Preliminary tests are being run by the set of four 3,500 shaft h.p. Fairfield-Sulzer two-cycle Diesel engines of the motorship for the Union Steamship Co. of New Zealand. These engines we had the pleasure of seeing last summer in course of construction. Each is a six-cylinder unit of 27½ in. bore by 39 in. stroke turning at 105 to 135 r.p.m., and giving from 12,500 to 14,000 shaft h.p. in aggregate.

A consolidation has been made of the Mianus Motor Works and the Mianus Diesel Engine Co., of Stamford, Conn., and the new concern will be known as the Mianus Diesel Engine Company and will assume full control of both firms. It has been capitalized for 10,000 shares of common stock and 5,000 shares of preferred 7 per cent stock, the par value of the preferred being $100 per share. Franklin S. Jerome of Seymour, Conn., has been elected President, with Wm. H. Shaw of New York City as Vice-President and George S. Watts of Stamford as Secretary and Treasurer. The Board of Directors, in addition to Messrs. Jerome, Shaw & Watts includes Clayton S. Boies, of Seymour, Conn.; Carlisle J. Gleason, of New York City; F. A. Hubbard, of Greenwich, and Charles D. Lockwood, of Stamford.

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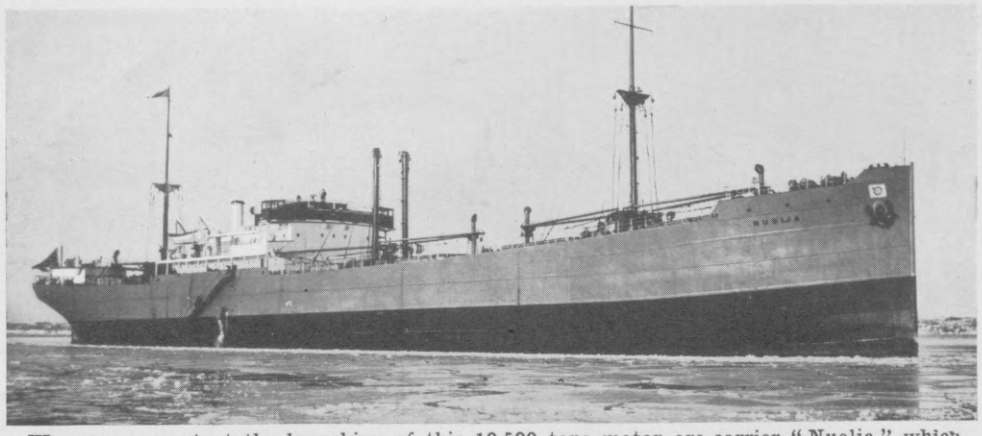

We were present at the launching of this 10,500 tons motor ore-carrier "Nuolja," which has just run trials at Goteborg. She was built by the Gotaverken and is powered with twin Gotaverken-B. & W. Diesel engines which on trials developed a joint output of 1,750 i. h. p. at 133 r. p. m., giving the ship an average speed of 11.1 knots. Her fuel consumption was 140 grams per i. h. p. hour.

Regarding the four 53 ft. motor tugs now under construction for the U. S. Engineers Office at Philadelphia of the War Department, two tugs were recently launched and are due to be completed about the middle of February.

At a recent meeting of the Board of Estimate for New York City, Acting Mayor Murray Hulbert refused to vote for an appropriation of $1,500,000 to enable Commissioner Grover A. Whalen of the Department of Plant and Structures to build eight new 150 ft. Diesel-electric driven ferryboats for service on the East River. As we close for press however, it is expected that the money will be appropriated at the next meeting. New designs are being prepared.

German shipyards are meeting the change in the shipbuilding situation by linking-up with oil-engine builders. Recently the Reiherstieg-Schiffswerfte, of Hamburg, formed an association with the Mannheim (Benz) Motorwerft. Now comes the news that the Schiffswerfte und Maschinenfabrik, ex Jansen & Schmilinsky, in Hamburg, have entered into an arrangement with the Deutz Motoren Fabrik in order to promote conversion of steamers to Diesels.

The orders received by the General Electric Company for the year ending December 31, 1923, amounted to $304,199,746, compared to a total of $242,739,527 for the year 1922, or a gain of 25 per cent., according to a recent announcement by Gerard Swope, president of that concern. For the fourth quarter of 1923, orders totalled $74,452,442, as compared with a total of $66,568,333 for the corresponding quarter in the year 1922, or a gain of 12 per cent.

In the 11,000 tons d.w. motor freighter building for the Golden Cross Line, managed by Owen Watkins Williams & Co., of Cardiff, are installed two Beardmore-Tosi 1,250 shaft h.p. oil-engines of the four-cycle type. These engines each have six cylinders 24 in. bore by 38 in. stroke and turning at 125 r.p.m. The hull is under construction at the Blythswood Shipbuilding Company's yard. The Golden Cross Line own the new motorship MARGRETIAN equipped with the first two Beardmore two-cycle engines designed by A. D. Chorlton.

All four Diesel engines built by Richardson, Westgarth & Co. under the Beardmore-Tosi license for the two motorships ordered by Furness Withy & Co. have now completed their tests. Two sets were erected at West Hartlepool, while the other two have been built at the Middlesborough works. As will be remembered, one of the Hartlepool engines was tested by the Marine Oil Engine Trials Committee, which body has since carried out tests on the Scott-Still engine and is preparing for the third test series with a Werkspoor engine.

CAPENA, a 7,700 tons d.w. and 11,200 tons displacement Diesel-driven Italian tanker recently ran trials. She was built for the Roma Steamship Co., of Roma, at the Savoia Shipyard, Cornigliano, Ligure. Both concerns for a long time past have been subscribers to MOTORSHIP. Twin 1,250 shaft h.p. Diesel engines are installed aft, and drive the ship at 10.5 knots. Length 393 ft. 9 in., breadth 51 ft. 10 in., depth 31 ft. 3 in.

Although the large Clyde engine shops of Harland & Wolff, at Finnieston and Scotstoun, are specially equipped for mass production of the various types of H. & W. engines, as constructed on the Burmeister & Wain system, arrangements have been made —as stated elsewhere—for building the new double-acting type at the Belfast works. Three twin-sets will be required for installing in two 22,000 ton gross mail liners ASTURIAS and AMAZON ordered by the Royal Mail Steam Packet Co., and in one 20,000 ton gross passenger vessel building for the Union Castle Steamship Co. The engines will be eight-cylinder double-acting four-cycle units 840 mm. (33.07 in.) bore by 1,500 mm. (59.04 in.) stroke, developing 7,500 s.h.p. at 125 revs. per minute, when driving their own air compressors or about 8,000 s.h.p. with separate driven compressors. This means 15,000 to 16,000 shaft h.p. per boat.

R. S. Dalglisch & Co., Newcastle-on-Tyne, England, must be added to the list of steamship owners converted to Diesel faith. Their latest order has been secured by Arch. McMillan & Son, Ltd., Dumbarton, Glasgow, embraces two single-screw vessels of about 8,000 tons d.w. measuring 400 ft. by 53 ft. by 29 ft. 7 in. The propelling plant of both hulls comprises one six-cylinder 1,650 shaft h.p. Harland-B. & W. long-stroke engine, 740 mm. (29.13 in.) bore by 1,500 mm. (59.04 in.) stroke, running at 85 revs. per minute. The speed of the ship will be about 10 knots, on a daily fuel consumption of 8 tons.

Swan, Hunter & Wigham Richardson Ltd., Newcastle-on-Tyne, have now launched the first of two sister vessels, building for the British India Steam Navigation Co. Ltd. This is the KISTNA, a steel vessel 287 ft. by 40 ft. by 24 ft., carrying about 1,650 tons d.w. One six-cylinder, Neptune two-cycle engine of 900 s.h.p., 17 in. bore by 35 in. stroke running at 120 r.p.m. will give the boat a speed of 11 knots. The engine is similar to those fitted on board the M. V. ARNUS. (See MOTORSHIP, December, 1923, issue.)

General Electric propelling equipment will be used in connection with the twin 225 b.h.p. Ingersoll-Rand oil-engines, for propelling the 8,000 barrel capacity Diesel-electric tanker recently ordered from the Staten Island Shipbuilding Company. This vessel is to be a bulk gasolene carrier for coastwise service. Each oil-engine will drive a 155 K.W. main generator and a 26 kilowatt auxiliary generator. The two generators will be connected in series and will drive a single 370 b.h.p. propelling motor, the vessel being of the single-screw type. Control will be of the Ward-Leonard or voltage type, being arranged for operation from the pilot house only. When the craft is in port, one of the main engine generators will be used for furnishing power for driv-

350 s. h. p. Winton-Diesel engined tug "D. M. Renton" owned by the Wilmington Transportation Co., Los Angeles, Calif. She is a sister to the Winton powered tug "David P. Fleming" illustrated on page 14 of our January issue.

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ing the cargo pumps while loading and unloading the tanker.

Thirteen years ago Nobel Bros., the great Russian oil company, gave the name ZOROASTER to a 4,000 tons, 1,000 shaft h.p. Kolomna Diesel-driven vessel. This name has also been given to the 5,100 tons single-screw motor-tanker just launched at the Gotaverken, Goteborg, Sweden, to the order of Consul-General Karl V. Hagelin, o Stockholm, who was one of the directors of the Nobel Oil Co., and whose son, Boris Hagelin, not long ago favored us with a personal visit. The ship is fitted with the new four-cylinder, 2,000 i.h.p. Nobel two-cycle type Diesel engine described in MOTORSHIP of December, 1922: Length of vessel 312 ft., breadth 49 ft., depth 28 ft., draft 23 ft. Her first trip is due to be made this month.

The "Zoroaster" is the third big Diesel-tanker built at Götaverken. It was the second one built for a concern controlled by the Nobel interests, the tanker "Hamlet" built by Götaverken in 1916 being the first one. The latter was ordered by Messrs. Nobel Brothers but was sold to a Norwegian firm during the War. It may be mentioned that the very first Nobel tank-boat, built in Sweden in 1878, carried the same name "Zoroaster."

On the berth which has been occupied by the "Zoroaster" the keel of the first one of the freight and passenger motorships booked for The Pacific Mail S. S. Co. of New York has been laid.

RECENT SWEDISH GOVERNMENT SUBSIDY LOANS.

Name of Company	Motor-vessel to be built or building (*Tonnage*)	Amount applied for	Grant proposed
Erik Forsberg Karlskrona	1,056 gross 1,077 "	50,000 kr.	25,000 kr
Rederiaktiebolaget Nordstjernan	6,550 d. w.	1,250,000 kr.	900,000 kr.
Redeiraktiebolaget Rex	2,500 d. w.	250,000 kr.	200,000 kr.
A/B Svenska-Amerika Linien	.....	500,000 kr.	200,000 kr.
Rederi. A/B Svenska Lloyd	.....	1,625,000 kr.	400,000 kr.
A/B Svenska Ostasiatiska Kompaniet	9,500 d. w.	1,360,000 kr.	300,000 kr.
H. H. Thorson Djupekara	240 d. w.	20,000 kr.	10,000 kr.
Rederiaktiebolaget Transatlantic	2,381 gross 2,282 " 5,615 "	5,000,000 kr.	200,000 kr.
Varmlands Rederiaktiebolaget	206 gross	150,000 kr.	75,000 kr.

Congress and Steamer Conversions

(*Continued from page 97*)

that comes in with her boilers all gone, her engines in bad shape, and she is a good performer and we feel we ought to have her reconditioned or repaired, I believe (I may be wrong, but I have tried to get that action taken by the board) that the funds we had we could utilize (instead of going to great expense and putting the same type of machinery and boilers back in that old ship, or that old machinery), to put up-to-date Diesel engines in it. That is my impression under that section 12. But we could not use the construction loan fund; as I understand, it is for private parties, not the Government.

Mr. Davis: Now it would not be the purpose of the Shipping Board, if this resolution or an amendment embodying the same terms should be adopted, to change section 11, in so far as it restricts the terms of sale or of the loan up to two-thirds of the cost of the vessel, in connection with reconditioning, would it?

Admiral Benson: No, sir; the idea is simply an extension, to retain the same conditions and all that we now have in section 11 and simply to extend it to the conversion of the engines into motor engines.

Mr. Davis: In other words, the sole purpose of the board, through this resolution or amendment, would be to authorize the Shipping Board to convert your ships to the internal combustion type and then to sell them, instead of loaning the money to private individuals for that purpose?

Mr. White: It would have to be so amended as to permit the fund to be used for private individuals for this purpose, also.

Mr. Briggs: I understand this resolution intends to do both; in other words, to give the Shipping Board authority to use the fund for that purpose, if necessary, and also to authorize the Shipping Board to make loans of that fund to private individuals for that purpose.

Admiral Benson: As I said just now, I believe and I think the board would agree with me, that we could use our funds, where we have extensive repairs to make, for putting in the Diesel engines; but what the board wants is to be authorized to use money that it otherwise would not use in ordinary circumstances.

Mr. Briggs: You mean to use the construction loan fund if necessary?

Admiral Benson: I would rather see it in a different fund, if possible; but if you gentlemen think it better to put in into the construction loan fund, I would suggest, in order that the thing might not be mixed, that you simply transfer an amount from that fund for this purpose. But I would not mix up the loan fund, which is intended entirely for private parties, with the Government work.

Mr. Bland: Is not that the only fund you have available, Admiral?

Admiral Benson: It is unless you made some other available.

Mr. Bland: In other words, this $75,000,000 is the only place you have to look for any money to do this work?

Admiral Benson: Yes, sir.

Mr. Briggs: You would have to have a specific appropriation or authorization by Congress, otherwise?

Admiral Benson: Yes, sir. I am simply stating the different views on that.

Admiral Benson: Yes, sir we have seventy-five millions now. Now, if you wish to transfer $25,000,000 of that to the Shipping Board to use for this purpose, I would suggest, if you do it, that you separate it entirely so that it will be a different proposition in order to keep things in order. That would be my idea.

Mr. Davis: I agree with you thoroughly on that, that the construction loan fund ought to be kept entirely separate from any other activities of the board.

Admiral Benson: That is the idea, so that there will be no mixing of the funds for the different purposes, etc.

Mr. Briggs: You would have to do either one thing or the other; you would have to have a specific appropriation by Congress, which you can get now under the authority for reconditioning your ships, or you would have to have authority to utilize part of this fund already on hand in the construction loan fund or to use the returns from operating receipts for such purposes?

Admiral Benson: Yes, sir; that is it exactly.

Mr. Briggs: Now, do I understand you definitely to state, the board is of opinion they will need additional authority to use this construction loan fund for loans to private interests for conversion purposes?

Admiral Benson: Absolutely, sir.

Mr. Larsen: Will any more become available under that section?

Admiral Benson: The law reads $25,000,000 a year for five years. There are two more years for it to run.

Admiral Benson: My recommendation to the committee would be that they limit the board in the amount; I would not recommend over $25,000,000 for its own commission work.

Mr. Larsen: If that is true, would it not be wise to offer an amendment to this resolution something along this line—limiting the amount to be used for this purpose to not exceed a certain sum?

Admiral Benson: I would strongly recommend that. Twenty-five million dollars I think would be ample to start on.

Mr. Briggs: You estimate that as being the cost of converting about 50 ships?

Admiral Benson: About 50 ships; yes.

Mr. Briggs: There is no limitation in this resolution, for the use of the construction loan fund, on the rates of interest to be charged, or anything else, in so far as the application is made to private parties, other than the general provision in the act itself, to which this resolution, however, does not even appear to relate.

Admiral Benson: I should make the same conditions that exist in section 11 apply to this resolution or any amendment you put to it, sir. That covers the amount and imposes on the board itself obligations and gives it sufficient discretionary power. And if the same conditions as are imposed by section 11 as it now stands for construction are imposed on the extension of the authority to use a certain amount of the construction loan fund for conversion, I think the situation would be completely met; but with the distinct understanding that it covers private parties as well as the Shipping Board. I think we want both; we want to be in a position to convert at least 50 of these ships and I think we can easily do it on $25,000,000, and we also want an extension of the authority to lend money to private parties for conversion as well as for construction. In my opinion, in the present condition of shipping, it is really more important that we be allowed to lend this money for conversion purposes than it is for building.

Mr. Larsen: I understand you to say the total amount available at this time is $75,000,000. The possible amount, at the expiration of the five years, will be $125,000,000.

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Mr. O'Connell: Now, I would like to ask, Admiral, whether this resolution, as it stands or with the amendment suggested as to the $25,000,000, carries out in your mind the purpose of the board?

Admiral Benson: I do not think it does, sir; and I would suggest, if you will allow us to do so, that I be permitted to submit to you my ideas.

Mr. Davis: I believe the committee would be glad to have you submit, on behalf of the Shipping Board, the general proposition you recommend, and I think, Mr. Chairman, it should be submitted in the form of an amendment rather than a resolution.

The Chairman: I think so myself.

Mr. Briggs: I think it is entirely inadequate so far as the purpose the board has in mind has been outlined here.

Mr. Davis: It covers the purpose of holding these hearings.

Mr. McKeown: I am thoroughly in accord with the necessity of putting in these motors, this Diesel motor or whatever type they may be, in order to put our boats in proper shape to compete or to keep up with the rest of the world. But what I want to know is whether the man who buys from the Government hereafter and gives a mortgage and is extended certain credit to purchase, is in the same position as the private buyer who buys tonnage, or the hull, before it is converted and gets a loan to convert.

Admiral Benson: In the final arrangement we certainly would make every possible effort at equalization, yes. I do not think it would be at all possible to create a condition that would favor either if we did. I would rather favor the man who bought the ship in the beginning and converted it. That is my view of it; that is, he is willing to take the risk and convert the ship. I would rather favor him.

Mr. Roach: I would like to know what the Budget submitted to Congress gives to the Shipping Board.

Mr. Conti: Fifty million dollars is the amount for the division of operations of the Emergency Fleet Corporation for the year ending June 30, 1924. Why, for all the expenses incident to the operation of this great fleet and the deficit accruing therefrom.

Mr. Roach: My understanding is it is divided into two parts, thirty millions for deficiency and twenty millions for rehabilitating ships.

Mr. Davis: They have just been making a lump-sum appropriation.

Mr. Roach: But they have changed it this year.

Mr. Nicholson: That means for next year, sir. Last year an appropriation was made which runs to June 30, 1924. You will find, I think, that the Budget always relates to the year ahead, so that I think what you are discussing is a proposition with respect to next year, after June 30, 1924. I do not know what the pending proposition is, but the proposition of last year, as embodied in this year's Budget, was $50,000,000 for all, is my recollection.

Mr. Davis: Why do you ask for $50,000,000 this year when you only expended thirty-two or thirty-three millions last year?

Admiral Benson: I thought we were only asking for thirty millions this year. We are asking for thirty, sir, for 1924-25. I think I get your idea; that is, if we have $20,000,000 for reconditioning, what do we want this other $25,000,000 for?

Mr. Roach: Yes.

Admiral Benson: We would not want both, I think; but I am not prepared, frankly, to answer that, because that it a phase I have not gone into.

Mr. O'Connell: We have had only this resolution before us for consideration. I think it would be very helpful to the members of the committee if the Shipping Board, who is so vitally interested in this matter, would submit to us in the form of an amendment to existing law, or in the form of a new resolution, such an amendment or resolution as would, in their opinion, effectually carry out the purpose for which you are appearing here to-day. Would you do that for the committee?

Admiral Benson: I would be very glad to do that.

Mr. Davis: You spoke of a number of studies you had there, which you would be glad to file as addendum to your testimony. Is there in there a statement giving the general experience of the *William Penn;* in other words, the cost of operation and the receipts, and dealing with the subject generally?

Admiral Benson: We have all of the data excepting the receipts. We have drawn a comparison there of the *William Penn* and the same kind and size of ship not equipped with internal explosive engines, so that it will give you just that data you want.

Mr. Davis: I wish you would also include in that not only the expenses of operation but the receipts collected from the operation of the *William Penn.*

Admiral Benson: We will do that the best we can. Of course, there are always a lot of things. I will say this, for the information of the committee: We have just recently reallotted the *William Penn* to the same company that is operating her and they have assured us a net revenue well on to $100,000.

Mr. Davis: On what terms have you reallotted her?

Admiral Benson: The regular MO-4 agreement.

Mr. Briggs: I would like to ask, in this statement made there of the conversion costs, if the cost of conversion of the present types of Shipping Board vessels also embraces up to 14 knots, as you indicated you were requiring for new construction?

Admiral Benson: Yes, sir.

Mr. Briggs: Do you contemplate in this conversion that any of the Shipping Board vessels, or a number of them, can be converted up to a speed of that kind by the utilization of the Diesel engines?

Admiral Benson: No; I do not think any of them can be forced to over 12 knots.

Admiral Benson: I think I have outlined what we have in mind as clearly as I could. I would like to submit the data I have here, which contain a lot of information. We have tried to put it in such form that it would be perfectly clear and not any more technical than necessary.

[*We are unable to find space this month for the mass of valuable information regarding steamer conversion and motorship operation submitted to the Committee by Admiral Benson, but we anticipate publishing some of it in our March issue.—EDITOR.*]

Mr. Roach: Will you also submit what the Budget requirements are for the coming fiscal year?

Admiral Benson: We will do that.

Mr. Davis: One thing further: Has the survey made by the Shipping Board developed the fact, or does the study you have made give any information as to the number of Shipping Board vessels that are readily and easily convertible into the Diesel type of operation?

Admiral Benson: Yes, sir; they are all divided up into different classes; those that are the most desirable to convert, those that are a little less so and others where there is a question whether it would be better to take out the good engines in them and put in Diesel engines, or not. We have tried to make that perfectly clear with the whole fleet.

Mr. Davis: For the entire fleet; not merely for the 50 vessels you have in mind?

Admiral Benson: No, sir; for the whole fleet.

Mr. Briggs: I would like to ask one other question, if there is any relation to your statement a moment ago that Diesel-type engines are found more economical in vessels on long routes rather than in vessels on short routes? That is correct?

Admiral Benson: Yes, sir.

Mr. Briggs: I understood Mr. Sheedy, who is one of the vice-presidents of the Emergency Fleet Corporation, also takes the same position as that. Then the actual experience of the board is that they have found for short distances, for instance, the steam vessel is as economical as the motor-driven vessel? I should like, if the information is at hand, just a statement of the results of the experience of the board with respect to that matter. I think perhaps that was incorporated in Mr. Sheedy's article to some extent, which I recently read in some magazine; but I think it would be well enough to bring those facts before this committee, because it certainly wants to give this matter the most careful consideration. My question relates to the fact, for instance, that the Diesel type engine required a few more crew, and meant an increase to some extent in the cost of food, and things of that kind, and then the article gave fuel savings for the distances traveled by the ship. That statement I think would be very helpful and very valuable to this committee.

Admiral Benson: I do not want you to feel the Diesel engine is not as good for the short trip as for the long one, because I think if it is good for one it is good for the other and I do not agree with the position taken by some people that the Diesel engine is less suitable for short trips.

Mr. Briggs: You understand what I want is the board's opinion.

Admiral Benson: I simply want to make myself clear, I do not agree altogether with the board.

Mr. Briggs: I understood from your general statement you thought the motor-type vessel would be preferred on long voyages, but possibly did not indicate any material saving, if any, on short voyages?

Admiral Benson: On account of the fuel. I said you could carry enough fuel to go and come back and would not have to buy fuel abroad at an exorbitant price. That, of course, is very desirable in long trips and makes it almost necessary. I would like to leave this thought. As I said just now, in my opinion—and I have given this careful thought for a number of years—I think it is more important that that money should be utilized for the conversion of the ships into Diesel motorships than it is that it be used for new construction; for the upbuilding and maintaining of the merchant marine.

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for our purposes. Now, with the steam vessel, for each cent spent for fuel, a ton of cargo can be carried 43 miles. With the vessel which was equipped with Diesel propulsive power, but with steam auxiliaries, each cent spent for fuel carried a ton of cargo 93 miles. With the ship where the conversion was complete, in which the propulsion and auxiliaries were both arranged for Diesel engine, each cent spent for fuel carried a ton of cargo 165 miles. That shows you the difference of complete conversion over partial conversion. The increase in the number of miles for each cent spent for the fuel was from 43 miles to 165 miles.

Now, that has another bearing. When a vessel goes to sea, it has to carry its fuel with it. If that vessel goes to the Far East, it has to carry the fuel to take it over there to the Far East, or to some intermediate port where it would be forced to stop, because it could not carry fuel enough. Now, for every day that vessel is at sea, you are increasing its dead-weight carrying capacity a little over 23 tons.

If it should be out for 100 days, that would be 2,300 tons. That is a big part of the carrying capacity of the ship.

In addition to that, with the Diesel ship, you require a smaller personnel; you do not require the fireroom personnel or anything of that kind, and you have a better sustained speed. With the steamship, it is more a personal matter with the firemen; they have to shovel the coal and attend the fires to keep up the speed of the ship. With the motorship you put the control levers in a certain position and machinery does the work. That is in line with present-day ideas; instead of depending on human workmen, let machinery do the work.

Mr. Larsen: What is the comparative maintenance cost?

Mr. Cooke: It is less on the motorship. You see, one of the big items of maintenance on the steamship is the boilers. I might say that on two ships which were built during the war and went out to Australia and having the same nominal power, one steam and one motor, the motorship used to go from San Francisco to Sidney, Australia, in 31 days, including a day's stop in Honolulu, and it took the steamship 31 days to go from Honolulu to Sidney.

Mr. Briggs: Do you know why, if it is true, that they require a larger crew on these Diesel-engine driven vessels than on the steam-driven vessel?

Mr. Cooke: To tell the honest truth, I did not know it was true. The facts, as I know them, are just the opposite.

Mr. Briggs: I am referring to an article, I think possibly by Mr. Sheedy, vice president of the Emergency Fleet Corporation; that is my recollection.

Mr. Cooke: In general, my idea is there is a smaller personnel on the motorship.

Mr. Briggs: That is my impression as to all oil-burning vessels, and as the Diesel is the higher type I do not see why there would be that difference.

Mr. Cooke: I think there must be some misunderstanding in regard to that. I might say that with the Diesel ship you have a smaller personnel than with the oil-burning ship, because the oil-burning ships have to have water tenders and two firemen, which would be eliminated with the Diesel ship.

Mr. Larsen: There is a certain percentage of salvage, also, is there not—or something of that kind?

Mr. Cooke: When the equipment is obsolete, such as steam equipment is to-day, there is a question of how much of a market you would get for your salvage. In other words, if you do not want to use it, is there anyone else who would want to use it? And a good deal of it is out of condition, and it is sold more or less for scrap.

(The following paper was submitted by Mr. Cooke:)

	Shipping Board steam vessel.	Converted to motor ship with steam auxiliaries.	Converted to motor ship with Diesel-driven auxiliaries.
Dead-weight tons.....	4,125	4,125	4,125
Average speed (knots)..	8.5	8	8
Average tons fuel per day	[1] 28	[2] 8	[2] 4½
Knots a ton of cargo is carried for each cent expended for fuel....	43	93	165

Statement of John G. Pew, Chester, Pa., President of the Sun Shipbuilding Co.

Mr. Pew: We have or are the owners of the Junker patents in America. We sent to Europe and succeeded in making arrangements with Doxford, who had the Junker patents in England, for making the American development; consequently we call the engine we build the "Sun-Doxford."

In March of this year we bought from the Shipping Board two tankers and one cargo vessel. The tankers were 10,250 dead-weight tons each; the cargo boat is 11,850 dead-weight tons. In June we had a Sun-Doxford engine installed in the first boat, the *Miller County.* She has made six trips to either Texas or Mexico and returned, and one trip to the Pacific coast. In July we had the *Bidwell,* the next tanker, completed. She immediately went to the Pacific coast and has gone to Europe and is on its road back. Both of these vessels have given us very good service. We are still operating them ourselves.

Mr. Briggs: At what knot speed?

Mr. Pew: At about 11.2 knots. The boats were built for 10¼ knots, I believe; they were built during the war. The *Challenger* is a cargo boat and has a carrying capacity of 11,850 dead-weight tons. She will make about 11 knots and will operate on less than 13 tons of oil a day for fuel. She originally took 33 and 34 tons of coal a day for fuel.

Mr. Briggs: In that connection have you any objection to stating the approximate cost of conversion, if you have it?

Mr. Pew: The approximate cost of conversion of each of these vessels, in the case of the tankers, was between $45 and $50 per dead-weight ton. Now, the *Challenger* will run between $55 and $60 a dead-weight ton; exactly how much I do not know. But she is entirely equipped with new machinery throughout, new pumps, electric-driven winches, stearing gear, and everything is new from top to bottom — everything except the hull. We are trying to put this vessel in first-class condition to demonstrate what an oil engine will do. The *Challenger* was built during the war by the Bethlehem Co. and has a good hull; it is an elegant hull. We understand that she had no trial trip, and the best information we can get is she is a trifle over 10 knots.

Mr. Briggs: Under this conversion, you have increased the speed?

Mr. Pew: We have not run her yet. We believe we will get about 11 knots with her, and cut down the fuel consumption about one-third.

Mr. Bacon: Was she an oil burner before?

Mr. Pew: She was an oil burner before.

Mr. Briggs: You have kept the costs rather carefully, have you, of the operation of the tankers?

Mr. Pew: Yes, sir.

Mr. Briggs: How do the costs compare? You need not give the details, but just summarize it.

Mr. Pew: In fuel only has the cost changed, and that is down to less than half of what the cost was before.

(*To be continued in March*).

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